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Army Aviation Cold Weather Operations

A/1-169th is a command aviation company (CAC) operating UH-60L aircraft, headquartered in Concord, New Hampshire. In February 2020, the company deployed three UH-60L aircraft, personnel and equipment to Eielson Air Force Base (AFB) in support of Exercise Arctic Eagle 2020. This exercise tested our unit's ability to deploy equipment while operating in an austere cold-weather environment. There were many lessons learned from operational techniques to work/rest cycles in the extreme cold.

Risk Assessment Planning

Temperature: Cold weather and snow is an immediate risk consideration when beginning the mission planning process of a winter operation in Alaska. During this training exercise, it was not uncommon for temperatures to range from -37 degrees Fahrenheit (F) to -10 degrees F, not factoring in wind chill. Even though we regularly train cold weather operations in New Hampshire, many aspects of this environment were foreign to us. To prepare for the arduous task of establishing our operations footprint we had to train accordingly.

Degraded Visual Environment/Skis: Leading up to this exercise we identified degraded visual environments (DVE) and the use of skis on the aircraft as one of the top training priorities. DVE iterations with skis were done to combat the deep and granular snow that we encountered in many remote helicopter landing zones (HLZ). What we now know about these operations is that it is critical for free information flow across the cockpit to ensure a safe landing. This meant many hours of practicing for a frigid DVE.

Preparation began with a review of the tasks and considerations in the aircrew training manual (ATM) for the specific conditions we would be flying in and then training that task accordingly. In New Hampshire, we are fortunate enough to have a large sandpit in our local flying area which we often use for DVE training. A large portion of our training prior to this exercise focused on DVE landings and we spent many blade hours in that sandpit.

We knew that even with this practice, DVE landings in the snow with skis would create new challenges to overcome. One of our first missions in Alaska was a Troop movement into a smaller HLZ surrounded by tall trees and bisected by power lines. The trail aircraft into the HLZ had difficulty clearing the aircraft of all obstacles leading to some confusion amongst the crew. When this was discussed during the mission after action review, it was established that the extreme cold weather was causing a reluctance in the crew to open the windows for as long as they had during our training in New Hampshire. We have determined, during confined area landings at home station, to maintain situational awareness during approaches requires the rear crewmembers to stick their heads out the windows to clear the aircraft. This was not being done due to the extremely cold environment.

Complacency: Landing in soft snow over and again can lead to complacency. For the pilots, it is paramount to pay close attention to the rate of descent with the expectation that this time, you might not be landing on that soft, spongy snow-covered ground.

A Maintainer's Perspective

Planning is paramount for maintainers battling exposure to cold weather. If work is to be done outside, limited exposure should be the goal. To achieve this, leadership and their maintainers must have a shared understanding of what task needs to be done and how to accomplish the task quickly and accurately. In Army aviation maintenance we do this by applying the P4T3 approach. Problem, Plan, People, Parts, Time, Tools, and Training (Army Technique Publication (ATP) 3-04.7, Army Aviation Maintenance).

Leaders and maintainers need to know which tasks will have to be done outside and how long they will take. Supervisors must thoroughly study the work packages along with the maintainers ahead of time and know what steps are to be done and in what order. With this information at hand, the leader can build teams to ensure that the work is accomplished with minimal exposure to the cold.

Have those teams gather the parts and tools needed to accomplish the task and always remember to train.

From a leadership perspective, limiting exposure is not the only way to mitigate the risk of cold weather injuries. Ensuring the Soldiers in your charge have the proper cold-weather gear, that it is serviceable, and that the Soldier knows how to use it is also important. Identifying shortages with ample amount of time prior to movement is key to success in this area. Fortunately for us, we were able to source the Extreme Cold Weather Gear (ECWX) and Fire Resistant Environmental Ensemble (FREE) System for all Soldiers prior to mission execution.

All that being said, one important aspect that is often overlooked is supervision. Army Technique Publication 3-04.7 tells us: "Supervision is an ongoing process throughout the entire phase of the repair. Section sergeants are responsible for the direct supervision of maintenance personnel who are performing specific jobs or repairs. Technical inspectors and aviation maintenance officers provide technical supervision throughout the execution of the maintenance task." This requires supervisors to get out there and share in the "suffering" from weather conditions their Soldiers are experiencing which will produce a better team.

A Coordinated Team Effort

In conclusion, there were many lessons learned during our operations in Alaska. Of them, the biggest lesson learned is that it is a team effort to overcome the severe cold weather environment and maintain operational capability. Whether it's sticking a head out of the window to clear an aircraft, noticing and discussing rate of descent, planning a way to limit the exposure of maintainers to cold weather, or ensuring proper crew coordination, it requires the whole team to successfully and safely execute the unit mission.

In no way would this training have been as big a success for our unit if we had failed to prepare and train properly. It took each and every team member from the private (PV2) up to the commander to be integrated into the preparation and training. Important team efforts included: Unit supply acquiring cold weather gear to negate shortages; supervisors learning and then training Soldiers how the FREE system layers worked; leaders planning adequate time for maintenance; and refining our tactics through de-brief sessions. ■

Recommended additional items for Cold WX OPS

- Cramp-ons for day to day operations
- Hydration systems
- Survival gear in the aircraft (ECWCS for crewmembers)
- External batteries/chargers to be plugged into electronic flight bags (IPAD) while in use. Extreme cold weather will drain batteries

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Evolving Manned/Unmanned Teaming: The Large Scale Combat Operations (LSCO) Fight

The core of successful aviation operations rests in a commander's ability to balance tactical and accidental risk. The risk to force and risk to mission is fluid, based on the decisions that he or she makes. Large scale combat operations will involve a significant increase in tactical risk. Aviation commanders will be required to leverage the entirety of their combat power efficiently and repetitively. Federated employment of manned and unmanned assets, in this type of fight, will result in higher mission risk. Unlike current combat operations, the integrated training and employment of manned/unmanned teaming (MUMT) will be a necessity on the future battlefield.

We tend to focus on the mitigation of accidental risk over tactical risk based on the nature of our aviation combat systems. This has been a function of the nature of aviation operations during the last two decades of low-grade persistent conflict. There are few documented situations in the last two decades of conflict when air superiority/supremacy was not guaranteed to us. Preparing for LSCO will require a realignment of our decision-making process and the training necessary to mitigate increased tactical risk. The commander must understand the capabilities they can bring to a fight and allow those capabilities to mature in their formation. In this way, they can recon or attack effectively when ordered to do so. Currently, we strike a balance of risk with individual and collective training. We validate our operations during combat training center (CTC) evaluations or warfighter exercises. The evaluation of aviation tactical/accidental risk, and the resulting risk decisions, can be vastly different. This depends on the branch of commander (e.g., aviation, infantry, field artillery) making the decision. Measuring the effectiveness of MUMT training is by nature, nuanced, and is shaped by the type of operation and type of formation that controls the assets. The reality is, risk to mission and risk to force are considered in very

different ways, depending on the mission.

Manned-unmanned teaming is defined as the integrated maneuver of Army aviation rotary-wing and unmanned aircraft systems to conduct movement to contact, attack, reconnaissance and security tasks. By that definition, if helicopters and unmanned aircraft systems (UAS) are not tasked with the same purpose and end-state on a given mission, then MUMT is not achieved. This lack of integrated tasking is where we assume risk to the mission. The varied capabilities of Army aviation systems have driven some units to utilize manned and unmanned aircraft in a federated manner. In some cases, this federated approach to desired effects is appropriate, but not doctrinal MUMT. For example, the utilization of UAS in the targeting cycle as a dedicated forward observer.

UAS Class Makes a Difference

In today's Army, three classes of UAS operators exist. The first class is defined as combat aviation brigade (CAB) tactical unmanned aircraft systems (TUAS). This class is represented by the RQ-7B shadow platoons, assigned organically within air cavalry troops, in an air cavalry squadron. This formation has the benefit of constant interaction with manned aviators/commanders and has the most opportunity to integrate manned and unmanned systems toward a common end-state. Like manned aircraft, accidental risk mitigation is part of the culture. Tactical risk mitigation is critically analyzed and applied when MUMT operations are called for. This formation has the greatest capacity for lethality on a LSCO battlefield if it is empowered to operate in an integrated manner.

The second UAS class is defined as the CAB MQ-1C Gray Eagle company. This company is assigned to or aligned with, the organic attack reconnaissance battalion (ARB) within a CAB. Due to the advanced capabilities resident within this company, they are infrequently teamed with their organic units. This fact highlights additional risk when preparing for LSCO operations. An ARB commander cannot currently rely on the utilization of their assigned Gray Eagle unit. These units are historically tasked with missions at higher echelons of command. In fact, most Gray Eagle companies operate on their own, and on a de-synced timeline from their assigned brigade headquarters.

There are associated increases in risk to force that Gray Eagle company commanders must assess, based on this arrangement. There is a great deal of counter-insurgency (COIN) experience in our Gray Eagle units. The demand for MQ-1C capability (precision strike) and the traditional (area reconnaissance) employment of the system, all but negates the Gray Eagle operator's opportunity to conduct MUMT maneuver on a repetitive basis.

The third class of UAS operators is the shadow platoons that reside within our brigade combat teams (BCT). These units operate in the traditional roles of artillery observation or area reconnaissance. In action, BCT shadow platoons rarely have the opportunity to conduct doctrinal MUMT and are not seen as a maneuver asset. The BCT shadow platoon is an important tactical risk mitigation tool for the BCT commander. Accidental risk mitigation takes a back-seat to the targeting mission, which is probably appropriate in this class.

The Challenges

All three classes of UAS operators are trained in the same pipeline. The UAS operator (15W) program of instruction does not delineate COIN versus LSCO operations. Professional expectation management for unmanned crewmembers varies with the types of units they are exposed to over a career. This fact presents challenges to situational awareness and understanding of risk. Regardless of unit type, home-station training for unmanned crewmembers share the same challenges. Infrastructure restrictions (airspace, range, weather) cause reductions in freedom of maneuver for planning unmanned operations. This has a cascading effect on planning effective MUMT training. Based on these restrictions, doctrinal MUMT operations frequently get exercised only during CTC rotations, due to the necessity of platform-pure training for both manned and unmanned aircraft. There are notable exceptions at duty locations that have the necessary infrastructure to support these training events. Units that commit the time necessary to integrate manned and unmanned aircraft at home station are more effective during CTC rotations or combat operations. This effectiveness stems from exposing both the manned and unmanned sides of this team to a standard and holding them to that collective standard.

While we do not typically think of MUMT as a combined arms operation, training MUMT capability shares similar challenges with training the conduct of traditional combined arms operations. This is even true inside a unit with organically assigned UAS and rotary-wing assets. Like any combined arms operation, units must share situational awareness and understanding in order to mitigate tactical risk and achieve the commander's end-state. They must train to standards within their own specialty, understand the responsibilities of other specialties, and rehearse the mission to standard. This shared understanding is what mitigates accidental risk in any formation, and is paramount in aviation formations.

The utilization of MUMT on the LSCO battlefield will be a significant mitigating force for tactical risk. Establishing situational awareness and understanding, before exposing manned assets to the enemy will be paramount. The capability to see the enemy with enough reaction time and maneuver space to effectively destroy them is powerful. This capability will come at the price of traditional federated employment of manned rotary-wing and UAS platforms. ■

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Safety Messages

For those of you who have limited contact with the quality control (QC) personnel, you may not be familiar with the term "safety messages." The term safety messages is focused on the official messages distributed through Army Materiel Command (AMC) and Life Cycle Management Command (LCMC). These messages are different from other safety messages disseminated by organizations like the United States Combat Readiness Center (USACRC) or messages that apply to other Army equipment. These safety messages are issued when AMC determines the safety of Soldiers or equipment is in danger. Messages are delineated and typed based on the risk level of an issue and the Life Cycle Management Command (LCMC) that distributes the message to the force.

Aviation and Missile Command (AMCOM)

The objective of the AMCOM Safety and Maintenance Messages (ASM) website is to provide users with the ability to access and view both aviation and missile safety messages. Aviation ground support equipment (AGSE) safety messages can be searched for under aviation. In addition, it will provide administrator privilege users the ability to upload the message files to the database and maintain them within the system. The system will also generate requested reports defined by the users. This one-stop shop assists the QC personnel with managing what applies to the mission, design, and series aircraft in their unit. Having the ability to search individual airframes instead of the entire database minimizes the critical downtime during maintenance.

Program Management: Quality Control

It is imperative for QC personnel to address every safety message that applies to unit aircraft and validate compliance and documentation. In accordance with Army Techniques Publication (ATP) 3-04.7 Army Aviation Maintenance, paragraph 5-82, once safety messages are complied with, technical inspectors making required entries on applicable Department of the Army (DA) forms according to DA Pamphlet (PAM) 738-751, Functional User's Manual for the Army Maintenance Management System-Aviation. All aviation maintenance units are required to submit a safety message compliance status report according to the instructions on their assigned aircraft. This ensures the Army is tracking equipment compliance as well as unit compliance. The TI's should scrub all logbooks for copies of applicable safety messages and air worthiness releases (AWR). Those not having the appropriate copies shall have the needed ASM or AWR scanned and made part of the electronic logbook.

Summary:

A periodic review of the AMCOM Safety and Maintenance Message (ASM) allows a unit to maintain currency and remain informed on relevant messages that might apply to your equipment. Ensure the Aviation Ground Support Equipment (AGSE) manager is aware of the information on this site. Keeping equipment fully mission capable (FMC) allows commanders the ability to remain flexible and limits their restraints when it comes to combat power. ■

References:

AMCOM Safety and Maintenance Messages (ASM) Website located at https://asmprd.redstone.army.mil/Default.aspx

- *AR 95-1 Flight Regulations*
- *AR 750-6 Army Equipment Safety and Maintenance Notification System*
- *ATP 3-04.7 Army Aviation Maintenance*
- *DA Pam 738-751 Functional User's Manual for the Army Maintenance Management System Aviation*

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Mishap Review:
H-67 Engine Failure

While conducting a day instrument flight training mission at 1,600 feet mean sea level (MSL) and 60 knots ground speed, the aircraft experienced an engine failure. The instructor pilot (IP) executed a power-off landing to an unimproved area resulting in significant damage to the aircraft. During the autorotation, the IP failed to execute the task to standard which resulted in a lack of rotor RPM for cushion during the landing phase. There were moderate injuries to all crewmembers.

History

The mishap crew's mission was to conduct instrument flight training tasks. The mission consisted of two training periods, with one student being trained during the 1st period, followed by a student swap at a local airport with a second student training during the 2nd period. The IP began his duty day at 1100 hours consisting of the daily IP briefing, where the risk assessment and manifest were completed. The risk assessment was approved by the flight commander. Following this, the IP was joined by his two student pilots (PI). The IP conducted the typical student PI briefing followed by a table discussion. Following the discussion the student PIs each prepared a performance planning card which the IP evaluated prior to preflight. With preflight completed, the aircraft departed the airfield under instrument flight rules (IFR) for the first training period.

The crew performed instrument-holding procedures and instrument approaches to a local airport. The IP landed the aircraft at the local airport following completion of the 1st period training. The second student PI then occupied a front crew seat and began the 2nd training period. The IP then received departure clearance to takeoff and departed on a westerly heading. During climb-out passing through 800 feet MSL, the IP made initial contact with the local approach control. Following the call, as the aircraft was at approximately 1,600 feet MSL, the rotor RPM began dropping. The IP took the controls and made adjustments to try to regain rotor RPM when the engine failed. The IP made a Mayday call to approach control, established an autorotational descent, and the aircraft impacted in the front yard of a private residence 1.7 miles west-northwest of the departure airport. The aircraft hit the ground, spun and rolled onto its side resulting in the destruction of the aircraft and injuries to each PI.

Crew

The IP had 231 hours in MTDS and 998 hours total time. The pilot (PI) had 47 hours in MTDS and 915 hours total time.

Commentary

The aircraft engine failed due to a spool bearing assembly failure as a result of fretting, which occurred when lubrication was lost over a period of time. The failure required autorotation to the ground. During the autorotation, the IP incorrectly judged the aircraft height above the ground, and rate of closure as he autorotated his aircraft to an open field in response to the engine failure. The IP extended the glide distance by prematurely applying collective to avoid a perceived obstacle, lost airspeed and rotor RPM resulting in insufficient RPM available for a safe termination. The IP's actions were a result of his inability to perform an autorotation to the ground safely because of an inadequate standard for instrument IP continuation training and annual evaluations.

The ability of PIs to successfully respond to an emergency that requires autorotation necessitates PIs to maintain currency in executing the task primarily in the aircraft. There is no substitute for actual in-aircraft hands-on execution of flight tasks. In accordance with the aircraft training manual, PIs should demonstrate proficiency in the aircraft and train to complete the tasks to standard to maintain their proficiency not only on the annual check ride but as a matter of continuation training. It can become common, during high paced operations, for IPs to have minimum time on the controls as they move new PIs through readiness level (RL) progression, no-notice evaluations, and annual evaluations. Remember, this hands-on performance may require more iterations than just those the IPs conduct when initially demonstrating maneuvers. ■

Class A - C Mishap Tables

	Manned Aircraft Class A – C Mishap Table									as of 15 Dec 20
	Month	FY 20					FY 21			
		Class A Mishaps	Class B Mishaps	Class C Mishaps	Fatalities		Class A Mishaps	Class B Mishaps	Class C Mishaps	Fatalities
1st Qtr	October	2	2	3	0		0	0	9	0
	November	1	0	2	2		2	3	6	7
	December	1	1	2	3		0	0	3	0
2nd Qtr	January	0	0	5	0					
	February	1	0	5	0					
	March	0	2	4	0					
3rd Qtr	April	0	1	1	0					
	May	0	0	6	0					
	June	0	0	6	0					
4th Qtr	July	0	2	8	0					
	August	1	2	6	2					
	September	0	2	7	0					
	Total for Year	6	12	55	7	Year to Date	2	3	18	7
	Class A Flight Mishap rate per 100,000 Flight Hours									
	5 Yr Avg: 0.94		3 Yr Avg: 0.99		FY 20: 0.63		Current FY: 1.40			

UAS Class A – C Mishap Table									as of 15 Dec 20
	FY 19					FY 20			
	Class A Mishaps	Class B Mishaps	Class C Mishaps	Total		Class A Mishaps	Class B Mishaps	Class C Mishaps	Total
MQ-1	5	2	3	10	W/GE	3			3
MQ-5	0	0	0	0	Hunter				
RQ-7	0	14	21	35	Shadow		1	3	4
RQ-11	0	0	1	1	Raven				
RQ-20	0	0	1	1	Puma				
SUAV	0	0	0	0	SUAV				
Other	0	0	1	1	Other				
UAS	5	16	27	48	UAS	3	1	3	7
Aerostat	3	0	0	3	Aerostat	0	0	0	0
Total for Year	8	16	27	51	Year to Date	3	1	3	7
UAS Flight Mishap rate per 100,000 Flight Hours									
MQ-1C Class A	5 Yr Avg: 8.40		3 Yr Avg: 5.71		FY 20: 4.82		Current FY: 19.72		
RQ-7B Class B-C	5 Yr Avg: 67.23		3 Yr Avg: 78.53		FY 20: 107.19		Current FY: 109.33		

Forum

Op-ed, Opinions, Ideas, and Information

(Views expressed are to generate professional discussion and are not U.S. Army or USACRC policy)

The Little Things

The story begins in October 2008 – I found myself as a newly minted fixed-wing (FW) graduate from the C-12 Army Aviation Course conducted by Flight Safety International in Dothan AL. An unpredictable series of events just happened to unfold systematically that led to me acquiring the FW qualification.

The initial event was being selected to attend the FW course to support my state deployment in the coming months. It simply came down to the needs of my state's C-12 fixed-wing unit. During the final phases of the pre-mobilization process, a pilot that was anticipating/expected to deploy with the unit for a 9-month rotation to Kuwait became medically disqualified. An immediate need for a school trained FW aviator suddenly opened - I was surprisingly offered the opportunity by the command to take an immediate school shortfall followed by a one-way rotator flight to Kuwait International Airport – the deal was made.

The Flight Safety FW transition course was all it was cracked up to be, 12 weeks of learning the nuances of airplanes verse the comfortable knowledge base we are all familiar with in the rotary wing community. The most difficult part to get used to was landing with a forward airspeed of 100 knots and becoming familiar with the new sight picture that defines a standard approach – to state it simply, it took some time to get used to. The training went as scheduled and I did find myself on that rotator flight a couple of weeks after graduation to join my new unit.

This being my first FW deployment, I was not sure what to expect. The C-12 deployment mission can either be a very important person (VIP) delivery asset overseas, or you can be tasked with the "ODIN" intelligence gathering mission (my unit was tasked with the VIP mission). I was immediately placed on the flight schedule to get trained up since the unit was running short one pilot for the first few months. Their goal was to make me readiness level (RL) 1 as soon as possible to relieve the pilot shortage and provide some breathing room on the schedule. Low and behold training was accomplished, local area briefings and orientations were completed, commander's evaluation and RL progression training were all completed with-in my first couple of weeks in theatre. I was a newly minted pilot (PI) ready for operational missions in theatre.

The unit did the right thing for the first month – I primarily flew with the instructor pilots (IP) in the unit till I got a few hours under my belt. I guess they liked what they saw that first month (didn't scare the living daylights out of them), so I eventually was released to the general pilot population to fly. The next several flights I made were your typical VIP missions deriving out of Ali Al Salem to locations such as Bagdad, Bahrain, Qatar, and Syria - All uneventful except for the rush always present when a two or three-star needs to be somewhere yesterday.

Now let's talk about that fateful day. It was one of those early morning take-offs in which the client was in a hurry to be at his other location. The loading went as usual – me being the junior PI, I helped load the passengers and luggage while the other pilot continued to work through the start-up. Once the passenger brief and luggage were all secured, I just needed to pull the cabin door closed and secure it. Sounds easy doesn't it … well it usually is. However, on this day when I was closing the door by the pull straps, I mistakenly crimped the strap in the door so it did not fully close. This should have been picked up when verifying the door handle is seated with the visual inspection window – I looked in the window however, it was too dark to clearly see the locking mechanism in the appropriate position. I assumed it was and continued on my merry way. I jumped up front and we finished the checks and we were cleared to taxi and take off without any issues.

We were lucky this morning, we had a short flight and a short day; we were only flying down to Bahrain which is about 45 minutes. Everything was going normal until about 10 minutes into the flight when we were cleared to our higher altitude.

We initiated our secondary climb when suddenly a master caution for cabin door unsecured light illuminated. My immediate thoughts were, "I am the guy responsible for securing the door!" followed by, "I didn't actually see the locking mechanism secured." I did look however but never confirmed. The pilot in command (PC) asked "Did I visually check the door upon closing?" and I came clean. We immediately visually confirmed from the front that the door was secured and informed our passengers to remain secured in the seats. The ascent up to 18,000 feet was not going to happen. The last thing we needed was to continue to pressurize the aircraft which could force the door open – un-pressurizing the aircraft. We immediately contacted air traffic control to request a lower altitude and ensured our passengers were seated and secure followed by ensuring all equipment was stowed in case of an accidental door opening.

The next 25 minutes were some of the longest of my life just thinking about the potential of the door opening. The door did not open in flight – luckily. Upon inspection when we made the landing at Bahrain, the PC confirmed the pull straps were crimped in the door and the alignment markings were off by ¼ inch indicating that the door was not fully seated. I was lucky that day. My inattention potentially could have led to a much greater issue and expensive aircraft accident. To say the least, when I was allowed to close the cabin doors in the future, I didn't care if it took two minutes to finally get a visual with lighting that everything was properly closed and aligned. ■

CW4 Thomas E. McNulty

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Blast From The Past: *Articles from the archives of past **Flightfax** issues*

Flightfax
ARMY AVIATION RISK-MANAGEMENT INFORMATION
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They SHUT DOWN the WRONG ENGINE!

On a clear night, two UH-60s were flying over water along a coastline. About 15 minutes into the flight, the crew of the trail aircraft radioed Chalk 1: "Hey, guys, your No. 2 engine is on fire!" They received no reply, but they watched as Chalk 1 immediately turned toward shore. Shortly thereafter, descending at 1,200 feet per minute, Chalk 1 hit the water at 214 knots, appeared to explode, and sank. All four crewmembers died instantly. This tragedy was the result of the crew's mistaken reaction to a single-engine emergency: a gas-generator turbine failure on the No. 2 engine. Their mistake?

Why?

As a result of this accident, the U.S. Army Aeromedical Research Laboratory (USAARL) undertook a study to determine whether pilots' reactions to single-engine emergencies in dual-engine aircraft are a systemic problem and whether the risks of such actions can be reduced. The goal of what has become popularly referred to as "The Wrong-Engine Study" was to examine errors that trigger pilots to shut down the wrong engine during such emergencies.

A two-part study was used to determine the extent and possible causes of errors made in response to single-engine emergencies.

Part I: Field Survey

USAARL and the Army Safety Center/Combat Readiness Center jointly developed a survey that would determine how often the errors of interest occurred, but were detected and corrected before they caused an accident. The survey was mailed to all brigade safety officers and medevac units down to company level with instructions to distribute copies to all dual-engine aviators. Participation in the survey was voluntary.

Of a target population of about 4,100 aviators, at least 350 responses were required for a reliable sample. Nearly twice that many—676—were returned, all of which were included in the analysis. Two questions yielded particularly important insight into the problem:

- Do you believe there is a potential problem of shutting down the operating engine during a single-engine failure/malfunction?

Just over 70 percent of the pilots surveyed believe there is a potential problem of shutting down the operating engine in a single-engine emergency.

- Have you ever moved or started to move the wrong power-control lever during a simulated or actual emergency?

In response to the second question, 39 percent affirmed that they had confused the power-control levers during simulated or actual emergencies. Nearly half of those (18% of the total) had actually shut down the "good" engine or moved the power-control lever.

The survey also asked pilots who had experienced confusion with the power-control levers to indicate what caused them to move the wrong lever. Nearly half of these aviators (111 of 224) indicated that their action was preceded by an improper diagnosis of aircraft condition. Other reasons given included design of the PCL (13), design of the aircraft (19), use of NVGs (10), inadequate training (34), negative habit transfer (10), hurrying (23), and inadequate written procedures (4).

As to the question of how to prevent aviators from shutting down the wrong engine, 75 percent of those responding recommended training solutions, while the other 25 percent recommended engineering fixes. Recommendations with a response frequency greater than five are shown in table 1.

Table A-3. Helipad assessment checklist

Training

- Improve Aircrew Coordination Training (129)
- Increase requirement for emergency-procedures training in simulator (96)
- Increase individual-proficiency training (79)
- Increase malfunction-analysis training (29)
- Changes to -10 (11)
- More detailed systems knowledge (11)

PCL design

- Label and illuminate (80)
- Change spacing/angle (25)
- Shape/code knobs (15)

Aircraft design

- Master warning lighting (15)
- Electric stop based on engine parameters (8)
- PCL audio "1" or "2" (5)

Behavior

- Slow down; stop hurrying (80)
- Think (27)
- Don't touch PCLs for single-engine emergencies (22)

Part II: Flight-simulator Study

Flight simulation was used to observe pilots in artificial emergency situations. Resulting data helped identify procedural and design modifications that could help reduce the risk of shutting down the wrong engine during single-engine emergencies.

The only inclusion criterion for the simulator study was that all subjects must be qualified in the UH-60. Informed consent was not required as the experiment involved normal training or other military duties as part of an experiment wherein disclosure of experimental conditions to participating personnel would reveal the artificial nature of such conditions and defeat the purpose of the investigation (USAMRDC Regulation 70-25).

Initial estimates called for 500 aviators (250 two-pilot crews). However, due to normally scheduled training, some aviators were observed on more than one occasion. Altogether, the 272 two-pilot crews observed included about 450 aviators.

There was no direct interaction with the subjects nor interference with their normal training. Subjects were briefed as usual by a rated aviator (usually the simulator operator or instructor pilot) on the mission profile to be flown and were required to conduct all preflight planning. Following the preflight briefing, the subjects entered the simulator and completed a 2-hour training flight. During the flight, the simulator operator exposed the crew to at least one of six randomly assigned conditions (engine fire, engine failure, high speed shaft failure, compressor stall, or torque split high and low side failures) that called for employment of single-engine emergency procedures. In addition, a failure presenting false indications of engine failure (an engine-out light and audio warnings associated with an alternator failure) were assigned at random to some subjects. Subjects' reactions to these conditions subsequently were analyzed to examine their information-processing and decision-making skills under simulated emergency conditions.

Results were that 15 percent of the participants in the simulator study reacted erroneously to the selected emergency procedures. One out of four of those erroneous reactions resulted in dual-engine power loss and simulated fatalities. Analysis of pilot reactions to indications of engine failure points to problems with the initial diagnosis of a malfunction (22 of 47) and errors in actions to correct the problem (15 of 47). Other errors included failure to detect cues arising from changes in the system (3), failure to choose a reasonable goal given the circumstances (for example, try to get home vs. land immediately) (2), and failure to execute proper procedures (5). The severity of these errors ranged from immediately realizing and correcting the mistake with no impact to actually shutting down the "good" engine, resulting in loss of the aircraft.

Conclusions

The bottom line is malfunctions that call for employment of single-engine emergency procedures are relatively rare events. However, such situations produce a one-in-six chance that the pilot will respond incorrectly to the emergency.

The study identified training measures to reduce this identified risk. In his 7 March 1997 message to aviation commanders, the Aviation Branch Chief outlined actions the Army Aviation Center (USAAVNC) has taken to implement these recommended changes in the training arena:

- **Increase aircrew coordination training.** USAAVNC is rewriting affected ATMs to ensure they adequately cover all single-engine failures and malfunctions and more strongly emphasize crew during academic portions of courses at USAAVNC, the GG-rotor problem is highlighted during the engine systems class and engine malfunction analysis class. In flight phases, the GG-rotor problem is addressed during the contact phase of training. Engine malfunction analysis is stressed, and the "two-pilot" mentality and crew coordination are emphasized.
- **Expand school training on correct engine malfunction analysis and emergency procedures.** During academic portions of courses at USAAVNC, the GG-rotor problem is highlighted during the engine systems class and engine malfunction analysis class. In flight phases, the GG-rotor problem is addressed during the contact phase of training. Engine malfunction analysis is stressed, and the "two-pilot" mentality and crew coordination are emphasized.
- **Increase simulator training with emphasis on malfunction analysis and emergency procedures to include all engine malfunctions associated with single-engine failures.** In the simulation phases of courses at USAAVNC, engine malfunction analysis is stressed, emphasizing correct identification and crew coordination before pilot action. In addition, iterations of engine malfunctions have been increased.
- **Revise -10 and checklist emergency procedures to remove ambiguity and stress control of the aircraft and time allowed for reaction.** USAAVNC reviewed emergency procedures in all multi-engine helicopter operator's manuals to ensure compliance with GG-rotor messages and "Wrong-Engine Study" recommendations. Changes to UH-60 and AH-64 operator's manuals will be fielded as manual revisions within 90 days. Several of the changes

will emphasize that the most important single consideration is helicopter control and that all procedures are subordinate to this requirement.

- **Increase individual aviator proficiency training.** The Aviation Branch Chief requested the assistance of field commanders in this area: "Although we have applied risk-control measures to our manuals and to the way we train in the schoolhouse, I need your help in increasing individual proficiency training. The AH64 combat mission simulator and the UH-60 flight simulator are cost-effective platforms to conduct the application and correlation levels of learning. During each simulator period, recommend you conduct at least one iteration of all engine malfunctions associated with single-engine failures, with emphasis on helicopter control, correct identification of engine malfunctions, and emergency procedures and crew coordination. The Division of Evaluation and Standardization will continue to emphasize performance planning, crew coordination, risk analysis, and single-engine emergency procedures on all field evaluation and assistance visits."

In addition to these training measures, further research is being conducted to identify possible engineering changes that could reduce the risk of pilots reacting improperly to single-engine emergencies in multi-engine aircraft. ■

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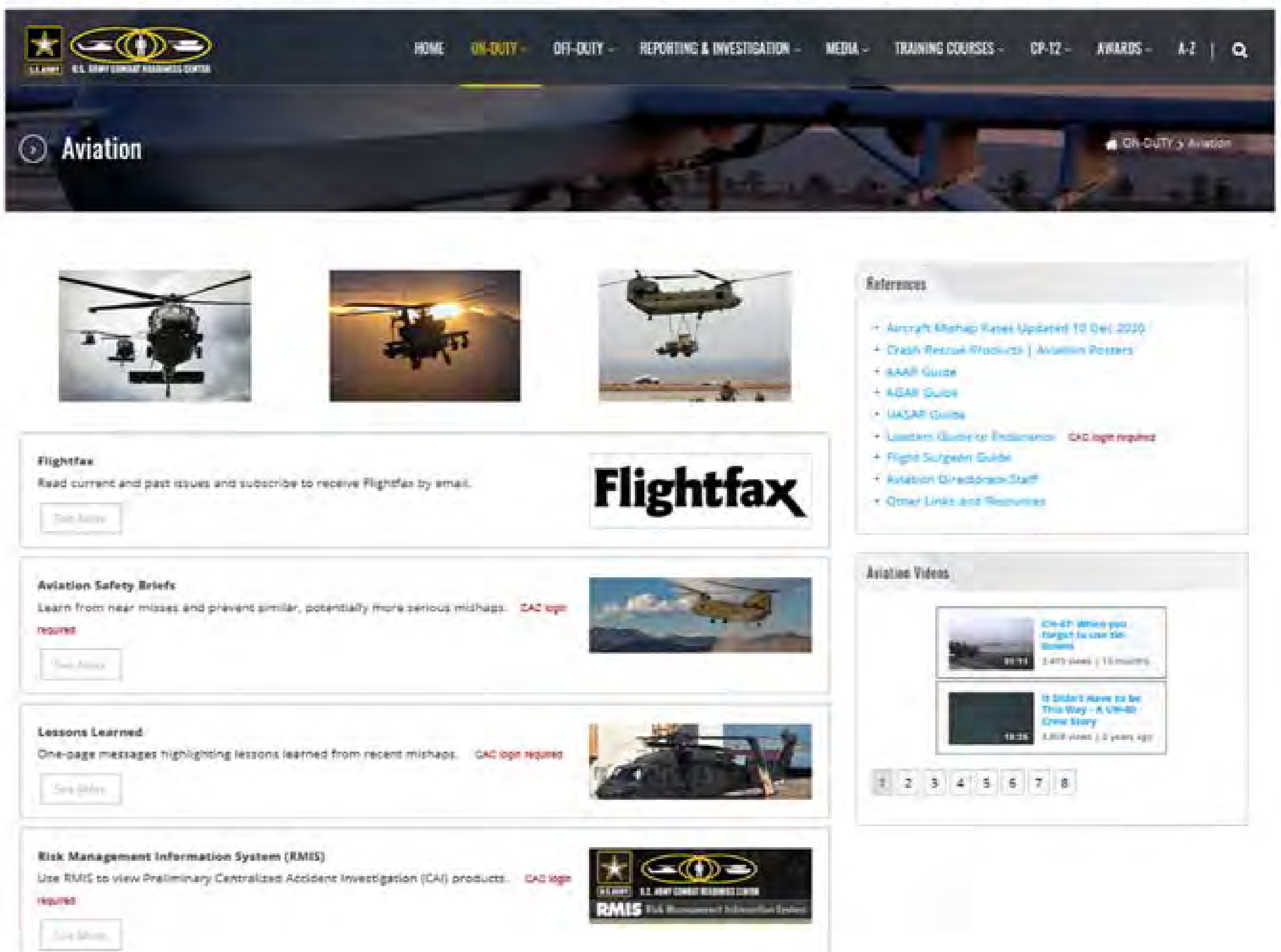
NOTE: UH-60 GG-rotor work was completed on 17 March 1997. The Black Hawk PM is working with the Apache PM to assist with the AH-64 GG-rotor program. The UH-60 POC is Mr. Dave Lizotte, 314-263-0485; AH-64 POC is Mr. Bill Reese, 314-263-6794.

Visit the U.S. Army Combat Readiness Aviation Division at: https://safety.army.mil/ON-DUTY/Aviation



H-47 Five-Year Mishap Review FY2016 - 2020

In the five-year period from FY16 through FY20 (386,000 plus flight hours), 47 H-47 Class A-C mishaps were recorded. There were 6 Class A (5 Flight, 1 Flight-related), 7 Class B (3 Flight, 2 Flight-related, 2 Ground) and 34 Class C (24 Flight, 4 Flight-related, 6 Ground), with a total cost in excess of $61.4 million in damage and injuries with no fatalities. Of the 6 Class A mishaps, 4 occurred under night vision goggles (NVG), and three were during deployments. Of the 47 Class A–C mishaps, 24 occurred under night (N)/NVGs.

The H-47 Class A flight mishap rate was 1.29 mishaps per 100,000 hours and 8.27 for Class A–C. For comparison, the overall Army rotary-wing (RW) Class A rate was 1.03 and the A-C rate was 6.78. The CH-47 Chinook comprises approximately 12 percent of the RW fleet, accounted for 11 percent of the RW flight hours, 16 percent of the Class A mishaps and 19 percent of the RW Class A-C mishaps. The previous H-47 5-Year period (FY11 – FY15, 447,900 hours) had a Class A rate of 2.46 and A–C rate of 13.17 with 1 fatality.

A review of H-47 Class A mishaps shows human error was the primary cause factor in five of the six (83 percent) mishaps with the remaining one mishap (17 percent) attributed to materiel failure. For all Class A - C mishaps, 31 (66 percent) were associated with human error, nine (19 percent) materiel failure, two (4 percent) environmental related (bird strike, wind damage) and five (11 percent) were not yet reported or unknown.

There were nine Class A–C blade, tree, wire, and object strikes recorded in the 47 incidents, three of which resulted in Class A damage. Two Class A mishaps were associated with ground taxi operations. A total of three brownout/dust landings were reported with one Class A, one Class B and one Class C mishap. The previous five-year (FY11-FY15) period had 11 Class A-C recorded dust landing mishaps, four of which were Class A.

A review of the major mishaps for the FY16-FY20 five-year period include:

Controlled Flight into Terrain (CFIT) / Object Strikes

1. **Dust landing. NVG.** Aircraft crashed in reported brown-out conditions during infiltration operation. Aircraft was destroyed without recovery. (Class A)
2. **Ground taxi. NVG.** Aircraft were ground taxiing for refueling at the forward arming and refueling point (FARP) when Chalk 1 was struck from the rear by the forward rotor blades of Chalk 2. (Class A)
3. **Ground taxi. Day.** The crew was ground taxiing at an airport when the aft rotor blades made contact with the corner of a hangar resulting in damage to all three aft rotor blades, two hangars, and two aircraft inside the hangar. (Class A)
4. **Blade strike. NVG.** The crew was conducting pinnacle landing training when the aft rotor system made ground contact causing aircraft damage and crew injuries. (Class A)
5. **Dust landing. NVG.** Aircraft made contact with concrete T-barrier during landing in brown-out conditions. (Class B)
6. **Tree strike. NVG.** The crew was attempting a confined space landing in an approved landing zone (LZ), while under NVG when the aircraft descended into trees with the aft blades, damaging all three aft rotor blades. The aircraft landed safely with no injury to the crew. (Class C)
7. **Wire strike. Day.** During air movement, the aircraft encountered wires at 200-300 feet above ground level (AGL) which stretched across a river. The aircraft struck the wires and climbed out following the wire strike. (Class C)

Power Management / Combat Maneuvering Flight

1. **Power management. NVG.** The pilot in command (PC) applied power, during approach to land, in order to arrest the excessive rate of descent and prevent a hard landing. The application of power resulted in an overtemp of both engines. (Class B)
2. **Combat maneuvering flight (CMF). Day.** While recovering from a CMF maneuver, the instructor pilot (IP) noticed instrument indications of a rotor overspeed reaching 117 percent. The IP terminated the training flight and returned to base. (Class C)

Maintenance / Ground Handling

1. A Soldier was conducting a ground inspection on one of two engines which were on a ground support equipment (GSE) stand when the engine came loose and rolled off the stand. The rolling motion triggered the second engine to roll off of the GSE stand/mount as well. (Class B)
2. A group of Soldiers were closing the hangar doors and failed to notice that an aircraft rotor blade was not fully in the hangar when the door was closed causing damage. (Class C)

Materiel Failure

1. **Aircraft fire. Day.** While ground taxiing to parking after a maintenance test flight, the CH-47F experienced a fire in the forward pylon aft compartment. The fire was caused by a wiring harness chaffing against a hydraulic line which released atomized hydraulic fluid into the compartment. An electrical arc ignited the fluid. (Class A)
2. **Engine fire. NVG.** A non-rated crewmember (NRCM) stated he saw a fire on the No. 2 engine. There was no indication in the cockpit of a fire. (Class B)
3. **Attitude anomalies. Day.** The crew reportedly experienced aircraft attitude anomalies during take-off, during which the aft wheels made repeated contact with the runway. The crew conducted emergency shut-down procedures. The flight engineer (FE) sustained injury to one knee in the mishap sequence. (Class C)
4. **Engine overtemp. Day.** Engine overtemp occurred (1000 degrees Celsius) during engine overspeed test. The crew proceeded with normal shutdown procedures without further incident. (Class C)
5. **Full authority digital engine control (FADEC) failure. NVG.** The crew experienced cockpit indication of FADEC failure of the No. 2 engine on start-up (engine control lever (ECL) placement to FLIGHT from the GROUND

position), resulting in NG and TGT exceedance. (Class C)

Miscellaneous

1. **External load. Flight-related. NVG.** CH-47F attempted to sling load an AH-64E resulting in damage to the Apache. (Class A)
2. **Environmental. N.** Wind gusts with possible micro-bursts from thunderstorms caused the blades of four Chinook helicopters to break free from their restraints causing damage. (Class B)
3. **External load. NVG.** The pilot (P) reportedly inadvertently released the sling load deploying contents outside the perimeter. (Class B)
4. **External load. Day.** While conducting sling load operations at approximately 2,000 feet AGL, the aircraft unintentionally released the sling load. The shipping container being carried was damaged and the contents inside. (Class B)
5. **The aircraft was hot loading a 463L pallet with engines at flight idle.** The FE failed to signal the forklift operator to stop in a timely manner and the forklift contacted the upper rear pylon. (Class C)
6. **Loss of door. Day.** The co-pilot door reportedly separated from the aircraft while in flight and was blown into the aft rotor system. The aircraft was landed without further incident and post-flight inspection confirmed damage to all main rotor blades (MRB). The door was not recovered. (Class C)
7. **Cockpit fire. N.** A fire initiated in the cockpit during post-flight shutdown procedures and resulted in class C damage prior to extinguishment by the fire department responders. The crew reportedly placed both ECLs in the STOP position prior to egress and disengaged the auxiliary power unit (APU) shutoff valve. (Class C)
8. **Rotor wash. NVG.** Rotor wash from another aircraft whose crew was positioning to land following refuel reportedly resulted in damage to the adjacent H-47 as its crew was conducting shutdown procedures. (Class C)

Summary

In addition to the 47 Class A-C mishaps, there were 37 Class D and 28 Class C incidents reported. Some of the leading D/E mishap reports included 11 external loads dropped or damaged, 11 additional object strikes often related to damage incurred when landing on unseen hazards and 12 additional reports of lost windows, ramp extensions, doors, hatches and open cowlings. There were nine reports of personal injuries due to slips, trips and falls working in and around the aircraft and cargo. None serious.

In direct comparison with the FY11-FY15 five-year period, the recent FY16-FY20 demonstrated a 13.7 percent reduction in flying hours, a 47.6 percent reduction in the Class A flight mishap rate and a 37.2 percent reduction in the Class A-C flight mishap rate. As previously highlighted, there was also a significant reduction of dust landing mishaps.

As with other RW airframes, reducing the factors associated with human error bring the greatest benefits in risk reduction. Quality real-time risk assessment associated with a course of action leads to proper decision making and mitigation of unsafe situations. ■

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H-47 CLASS A-C MISHAPS

FY	Class A	Class B	Class C	Class D	Class E	Fatalities
2016	1	0	5	13	6	0
2017	0	1	7	6	3	0
2018	1	0	8	6	4	0
2019	2	1	4	6	7	0
2020	1	5	10	6	8	0
Total	5	7	34	37	28	0

H-60 Five-Year Mishap Review FY2016 - 2020

In the five-year period from FY16 through FY20 (over 1.7 million flight hours), 160 H-60 Class A-C mishaps were recorded. There were 18 Class A (15 Flight, 3 Flight-related), 16 Class B (14 Flight, 2 Ground) and 126 Class C (83 Flight, 30 Ground, 13 Flight-related) with a total cost in excess of $368 million in damage and injuries including 18 fatalities. Of the 18 Class A mishaps, 12 occurred under night vision goggles (NVG), seven were deployed, one at the National Training Center (NTC) and one at the Joint Readiness Training Center (JRTC). Of the 112 Class A–C Flight mishaps, 54 occurred under NVGs.

The H-60 Class A flight mishap rate was 0.87 mishaps per 100,000 hours and 6.56 for Class A–C. For comparison, the overall Army rotary-wing (RW) Class A rate was 1.03 and the A-C rate was 6.78. The Black Hawk comprises approximately 54 percent of the rotary wing (RW) fleet, accounted for 47.9 percent of the RW flight hours, 41.9 percent of the Class A mishaps and 48.5 percent of the RW Class A-C mishaps. The previous H-60 5-Year period (FY11 – FY15, 2.01 million hours) had a Class A rate of 1.04 and A–C rate of 6.81 with 24 fatalities.

The H-60M represent 43 percent of the H-60 fleet and flew nearly half (49%) of the total H-60 hours and were involved in 61 percent of the Class A mishaps and 49.4 percent of the total H-60 Class A–C mishaps. The H-60M Class A rate was 0.95 and the A–C was 6.87.

A review of H-60 Class A mishaps shows human error was the primary cause factor in 83 percent of the mishaps with the remaining 17 percent attributed to materiel failure. For all Class A - C mishaps, 74 percent were associated with human error, 12 percent materiel failure, nine percent were environmental related (bird strikes, lightning, winds) and five percent were not yet reported or unknown.

There were 30 Class A–C blade, tree, terrain, and object strikes recorded in the 160 incidents, of which five resulted in Class A damage. Three Class A mishaps (11 total A-C) were associated with ground taxi operations. A total of 19 brownout/dust landings were reported with three Class A and five Class B and 11 Class C mishaps. A review of the major mishaps for the five-year period include:

Controlled Flight into Terrain (CFIT) / Object Strikes

1. **Ground taxi. H-60M. NVG.** While departing the forward arming and refueling point (FARP) the main rotor of the UH-60M contacted the tail rotor and vertical stabilator of an adjacent AH-64D resulting in separation of the tail rotor assembly. Additional damage from foreign object debris (FOD) occurred to a parked CH-47F. (Class A)
2. **Engine failure. H-60L. NVG.** While maneuvering at low level following an engine failure, the aircraft descended, contacted a tree, and crashed. (Class A, 1 fatality)
3. **Ground taxi. H-60L. NVG.** While ground taxiing to parking at a civilian airport the aircraft's main rotor made contact with the control tower building. (Class A)
4. **Dust landing. H-60M. NVG.** During a dust landing the aircraft's main rotor blades contacted the ground causing extensive damage to the hydraulics compartment area and cockpit. (Class A, 1 fatality)
5. **Ground taxi. H-60M. NVG.** Aircraft was ground taxiing off the active runway when the taxiway matting reportedly released from its anchoring points and blew up onto and covered the cockpit. Damage reported to the aircraft structure as well as the forward looking infrared (FLIR) and radar. (Class A)
6. **Fast Rope Insertion/Extraction System (FRIES). H-60M. Day.** Following takeoff from the training site after egressing four soldiers, the FRIES rope made contact with the tail rotor system resulting in loss of control and subsequent crash. (Class A)
7. **Dust landing. H-60L. NVG.** Aircraft was landing for a MEDEVAC mission when the crew reportedly experienced brown-out conditions. Aircraft overturned upon contacting the ground. (Class A)
8. **Spatial disorientation. H-60M. NVG.** Aircraft was Chalk 2 in a flight of two overwater and at altitude when the crew became spatially disoriented. The aircraft crashed into the water. (Class A, 5 fatalities)
9. **Dust landing. H-60M. Day.** Aircraft overturned onto its right side upon touchdown in high dust conditions and main rotor blades made contact with the ground. (Class A)
10. **Blade strike. H-60A. NVG.** Aircraft main rotor system made contact with the driveshaft cover, intermediate gearbox cover, driveshaft flexible coupling, and troop commander antenna, during aerodynamic braking, subsequent to a roll-on landing. (Class C damage is suspected)

Power Management / Combat Maneuvering Flight

1. **Combat maneuvering flight (CMF). H-60L. Day.** While conducting CMF training, the aircraft descended to an altitude where it struck a tree and subsequently broke into two sections, destroying the aircraft and resulting in fatal injuries to all four crew members. (Class A, 4 fatalities)
2. Gunnery. H-60M. Day. During a diving fire gunnery engagement the aircraft descended and impacted the ground. (Class A, 2 fatalities)

Maintenance

1. **Maintenance. H-60L. Day.** Aircraft was conducting a maintenance test flight for the replacement of a hydro-mechanical unit (HMU) when the No. 1 engine failed during a maximum power check. The aircraft subsequently crashed. (Class A, 3 fatalities)
2. **Maintenance. H-60A. Night.** During a blade fold, the ground crew did not install the main rotor hub bracket on the main rotor hub to limit the travel of each blade, which allowed for class C damage. (Class C)
3. **Engine FOD. H-60M. Day.** During phase inspection, a spool of 0.020" safety wire was found in the No. 1 engine inlet of the helicopter which caused damage to the engine. (Class C)

4. **Maintenance. H-60L. Day.** Maintenance personnel experienced an engine turbine gas temperature (TGT) exceedance on ground-run start-up due to the engine inlet plug still installed. (Class C)

Materiel failure

1. **Materiel failure. H-60L. NVG.** Aircraft sustained damage upon landing subsequent to an in-flight emergency. (Class A)
2. **Materiel failure. H-60L. Day.** Aircraft was Chalk 3 in flight of three in a training flight when it crashed following loss of a tail rotor paddle and gearbox. (Class A, 1 fatality)
3. **Materiel failure. H-60M. NVG.** Following an engine failure during an overwater training mission the aircraft crashed into the ocean. (Class A, 1 fatality)
4. **Materiel failure. H-60L. Day.** During engine shut down the No. 2 Engine TGT spiked to 999 degrees Celsius for 9 seconds causing engine damage. (Class C)
5. **Hoist. H-60L. Day.** Crew was conducting hoist reset when they experienced a hoist cable/motor malfunction, reportedly resulting in detachment of the cable from the hoist. A 600-lb concrete load descended to ground impact w/o ground/property damage. Hoist cable damage is reported. (Class C)

Miscellaneous

1. **Personal injury. H-60M. NVG.** One foreign soldier fell to ground impact while exiting the aircraft during infiltration training. (Class A, 1 fatality)
2. **Personal injury. H-60M. NVG.** During go around on an infiltration, one U.S. Soldier exited the aircraft while it was still airborne. (Class A, 1 fatality)
3. **Hoist. H-60M. NVG.** Soldier/Medic fell approx. 20-30 feet into a wooded area while being hoisted during MEDEVAC training. (Class A, 1 fatality)
4. **Environmental. H-60L Day.** Parked aircraft sustained damage to the main rotor system during high wind condition on the airfield. Aircraft was moored/tied down at the time of the damage. (Class C)
5. **Gunnery. H-60L. NVG.** Suspected ricochet round penetrated main rotor blade during aircraft gunnery, causing rotor blade damage. (Class C)

Summary

A wide range of other incidents in lesser numbers were also recorded. Six reported incidents of an engine or inlet cover left in place during engine start. Seven hard landings with damage as well as a dozen TGT overtemps, many occurring during shutdown. There were three incidents in which the engine oil cap was unsecured. Additionally, turbine engine FOD incidents (Class F) for the time period numbered 16. No significant wire strikes were reported during this 5-year period. Although not as significant in dollar cost, 60 Class D and 79 Class E mishaps were also reported along similar trend lines found in the Class A–C incidents.

Targeting human error is key in reducing the number of mishaps. Leaders, aviators, noncommissioned officers, and enlisted Soldiers should use this review as a method to decrease simple human error mistakes such as not utilizing the checklist appropriately (engine inlet cover not removed before flight, FOD in inlet, oil cap not secure.) These simple mistakes can lead to catastrophic consequences. By taking active measures, every member of the aviation team can be the Soldier who prevented the catastrophe from occurring. Make sure every Soldier understands their role in eliminating human error. Following the established procedures in identifying and mitigating risk, following the mission approval process and maintaining standards and discipline in the conduct of aviation operations greatly enhance the ability for mission success. ■

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H-60 CLASS A-C MISHAPS						
FY	**Class A**	**Class B**	**Class C**	**Class D**	**Class E**	**Fatalities**
2016	2	3	20	14	23	4
2017	7	2	34	12	11	8
2018	3	3	32	8	12	1
2019	3	4	19	12	15	3
2020	3	4	21	14	18	5
Total	18	16	126	60	79	21

MQ-1C Gray Eagle Five-Year Safety Performance Review FY16-20

The MQ-1C Gray Eagle (GE) unmanned aircraft system (UAS) is a valuable force multiplier, allowing commanders to dynamically apply intelligence, surveillance, and reconnaissance (ISR), security, attack and precision strike capabilities across the breadth of the operating environment. Initially deployed as a quick reaction capability (QRC), the Gray Eagle has since amassed over 416,452 flight hours from FY16-20. Yet, the unfettered demand and growth of the Gray Eagle (block one) UAS during the past 5 years have come at a cost.

In the last five-year period from FY16 through FY20, the MQ-1C Gray Eagle program had a total of 60 MQ-1C Class A-C mishaps reported. There were 36 Class A, 10 Class B (one ground) and 14 Class C (one ground) mishaps, with no injuries or fatalities reported. The Class A flight mishap rate was 8.40 and the A-C rate was 13.45 for FY16-20.

In general terms, mishaps normally fall into three causal (error) categories: Materiel Failures (MF) that encompass failure of a component or system; human factors where human errors lead to a mishap; and environmental mishaps in which unknown or unavoidable environmental factors cause the mishap. Mishap causation may entail a single causation or a combination of two or more categories. Many times multiple factors within a specific category are the cause.

The 5-year review of MQ-1C Gray Eagle mishaps shows human error (HE) failure was the primary cause factor in approximately 27 of the Class A-C mishaps. Materiel failure (MF) was the cause factor in approximately 23 of the Class A-C mishaps and 10 were environmental or unknown. The following are highlights of the more frequent categories of UAS mishaps.

Human Error

Of the three categories, commanders of Gray Eagle units have the greatest influence over the HE failures. This is because supervision, training, and enforcement of standards –key to reducing HE- fall directly in their lane.

What do these HE mistakes look like? They can be as small as not following the checklist, such as not removing frost on the aircraft which starts an accident sequence, or they may be as large and significant as improperly calculating weight and balance which directly and immediately affects a mishap outcome. An analysis of the HE failures provides details commanders can use to identify and input the appropriate controls to correct these failures. Following are several examples from mishaps:

- Failure to remove frost from aircraft.
- Improperly calculating weight and balance.
- Improper maintenance procedures.
- Failure to follow procedures.
- Checklist not followed or procedures not followed causing loss of UAS.

These examples demonstrate the multiple failures involved from performance-based to inadequate supervision (Human Factors Analysis and Classification System.) As Soldiers execute their military occupational specialty (MOS) tasks, by-the-book maintenance and checklist use is a must. As we decipher these mishaps, a lack of oversight clearly stands out. Commanders reviewing these should note how important their leadership and direct involvement is to setting the example and enforcing high standards. Subordinate leaders have to take action to intensely supervise those operational tasks where the HE mishaps are occurring. Commander spot checks are a good way to ensure that the right things are being done. Asking questions and verifying subordinate leaders are more involved with Soldiers conducting the work assist in reducing these mishaps. Following are some HE examples:

1. **Human Error:** (Frost Removal x2) MQ-1C GE- Did not lift off the ground during an automatic takeoff and landing system (ATLS) takeoff and then crashed off the departure end of the runway. It was later reported that the aircraft was destroyed during the impact sequence. The UAS ran off the runway during launch operations and crashed into a fence line. The aerodynamic performance observed in the data logs is consistent with frost accumulating on the aircraft's horizontal surfaces, but not being removed before takeoff. Estimate Class A damage, aircraft recovered.
2. **Human Error:** (Weight Balance Error x2) The mishap flight revealed a ramp weight of 3,515 pounds and an operating weight of 2,728 pounds. The data logs indicated a ramp weight of 2,728 pounds. The operating weight from Form F was most likely entered for the ramp weight in the Vehicle-Specific Module (VSM) presets step of the "Initial Link" procedure. Because entered ramp weight was 800 pounds less than actual ramp weight, calculated stall speed was approximately 8 knots lower than true stall speed. This resulted in early rotation and delayed liftoff during the ATLS takeoff. The erroneously low ramp weight also resulted in a significantly lower calculated Coefficient of Lift (CL) than that associated with an accurate entered ramp weight. Class A damage, aircraft recovered.
3. **Human Error:** (Improper Maintenance Procedure) MQ-1C crashed following a launch from a deployed location. Approximately three hours into the flight, the mishap aircraft experienced reduced gearbox oil pressure, resulting in a loss of propeller pitch control, an engine overspeed, and an inability to maintain altitude. Teardown inspection concluded that the gearbox oil plug was only hand tightened following completion of a 100-hour maintenance action which was performed just prior to the flight. Insufficient torque was applied to tighten down the plug, causing the loss of gearbox oil pressure and propeller pitch control during the mishap flight. The aircraft wreckage was recovered and the mishap engine was returned to the equipment manufacturer for inspection.
4. **Human Error:** (Failure to Follow Procedures) A MQ-1C impacted terrain during an ATLS approach. The aircraft was returning to base due to a low coolant indication that began at liftoff. After performing a 360-degree turn on the downwind leg, ATLS land mode was selected and the landing gear was extended. The aircraft began a descending turn toward the base leg of the ATLS approach. It followed the ATLS profile and impacted terrain while turning toward final approach. While responding to an in-flight emergency

and utilizing the ATLS with an MQ-1C, Unmanned Aircraft (UA), the aircraft commander (AC) delayed his decision to abort the ATLS landing sequence in contravention of TC 3-04.63, Task 1081, Perform Automatic Takeoff and Landing System Abort. That is, recognizing the rapid rate of closure between the aircraft and the terrain, the AC confirmed the aircraft altitude by referring to the altimeter above ground level 2 (ALT AGL 2) which indicated >740 feet AGL. Hearing no terrain warning, and believing the payload video skewed the aircraft/terrain relationship the AC did not abort the ATLS landing sequence. As a result, the aircraft impacted the terrain and was destroyed.

5. **Human Error:** (Checklist Not Followed) Crew experienced loss of line of site with UAS during final approach and reported attempts for alternate ground and satellite terminal linkage were unsuccessful. Aircraft was recovered following crash landing with class A damage and was recovered.

The first checklist error occurred during the return to base (RTB) when the operator failed to point the Modem Assembly (MA) lower directional antenna toward the Universal Ground Data Terminal (UGDT) as instructed by the "Intra-GCS SATCOM-to-LOS" checklist. Earlier in the mission, the operator directed the MA directional antenna to point to a location near the aircraft. Because the pointing was not updated to the UGDT, the MA directional antenna continued to point to the operational area (approximately the opposite direction of the UGDT), which caused issues establishing an LOS data link.

The second checklist error occurred during preflight when the operator uploaded Tactical Common Datalink (TCDL) lost link settings that directed antenna pointing toward the coordinates (0° N, 0° E) instead of toward the UGDT. These erroneous lost link settings were applied when the aircraft began executing lost link logic shortly after the first landing abort. This caused the MA directional antenna to point to the southwest for the remainder of the flight which resulted in issues maintaining a consistent LOS data link.

Materiel Failure

Materiel failure is second leading mishap cause factor. Materiel failures are addressed by the program managers (PM) to improve reliability of the system and parts. This may be through design changes, product improvements or limiting exposure of existing systems to operate within limits that increase operating times. Additionally, the PM may determine maintenance actions to reduce failures or adjust component replacement hours based on failure historical data. There were numerous MF mishaps over the past 5 years, to include, fuel rail issues, oil cooler failure, alternator failure, fuel pumps, and turbo-chargers. All MFs are met with support from the PM and original equipment manufacturer (OEM) to either fix the issue or redesign the part to preclude materiel failure.

1. **Materiel Failure:** (Fuel Rail x3) Aircraft crashed following reported full authority digital engine controller (FADEC) degradation during flight and ENGINE-OUT during descent for emergency landing in RTB mode. The mishap aircraft was being flown under remote site operations from Ft. Stewart. They transferred control to the overseas site. About an hour after the site lead was notified of the FADEC degrade, the aircraft crashed just outside the base into the wall of a compound. The crew reported fluid leaking on the camera video just prior to the event, believed to be fuel, and a drop in fuel pressure. A review of the logs indicates most likely root cause of the incident is a problem in

the high pressure fuel rail system. The mishap data logs and payload video indicated that the aircraft experienced a high-pressure fuel leak during flight. Inspection of the engine identified a fuel leak at the No. 1 cylinder high-pressure fuel line fitting ferrule, nearest a broken fuel rail mounting tab.

2. **Materiel Failure:** (Oil Cooler) The crew received a low gearbox pressure warning during RTB. The crew received an engine over speed warning next. The mishap hardware determined a UWA41089-1 hose fitting attached to the oil pump outlet appeared to have a crack across its sealing surface, resulting in a slow gearbox oil leak and loss of pressure. The slow leak is consistent with the slow pressure degradation observed in the data logs. The reduced gearbox oil pressure prevented the propeller pitch controller from increasing blade angle to the commanded value, resulting in an inability to maintain commanded altitude at the commanded airspeed. The aircraft crashed about 10 nautical miles from base with three hellfire missiles onboard. Aircraft was recovered with Class A damage.
3. **Materiel Failure:** (Fuel Pump Failure) While increasing airspeed to return to base, an MQ-1C experienced a catastrophic failure of the fuel delivery system which resulted in fuel starvation and an engine shutdown. The failure of the fuel delivery system prevented the crew from restarting the engine, which resulted in a power-off descent and then a commanded self-destruct due to the tactical situation. The aircraft impacted the ground and resulted in the total destruction of the aircraft. The board, in consultation with systems engineers, determined from telemetry data that the failure likely originated somewhere between the low and high pressure fuel pumps. The aircraft was not recovered and was ultimately destroyed in place, preventing a detailed examination of the materiel failure.
4. **Materiel Failure:** (Turbo-Charger x 5) While operating at 20,000 feet, the engine turbocharger (P/N SCD01208-1) on an MQ-1C Gray Eagle UAS failed to produce adequate manifold air pressure (MAP). The UAS was not able to stay airborne. As a result, the UAS descended in vicinity of its base airfield and impacted the ground causing significant structural damage to the UAS. The failure was suspected to be caused by the turbocharger shaft bearing, which allowed the impeller wheels to contact the compressor housing and the turbine wheels to shear from the turbo shaft. This sudden stoppage of the turbocharger reduced engine performance. The aircraft crashed approximately 12 nautical miles from base and was recovered with Class A damage.

Environmental

According to Department of the Army (DA) Pamphlet (PAM) 385-40, Army Accident Investigations and Reporting, environmental factors can be divided into those which could not have been avoided, and those which could have been avoided or precautions implemented to reduce or eliminate its adverse effects on personnel and/or equipment. An environmental deficiency should not be assessed as a causal factor if it was known and could have been avoided before the accident. Examples are lightning strikes, hail and unforecast winds.

The environmental category also includes electromagnetic environmental effects (E3), formerly known as electromagnetic interference (EMI), which is a recognized potential accident cause factor, and should be thoroughly evaluated during all UAS accident investigations to determine whether it influenced the operation of the equipment involved.

1. **Environmental:** (Lightning Strike) Post-flight inspection revealed cosmetic paint damage to the radome and scorch marks on the tail cone, right wing tip, and UHF/VHF antenna. All damages sustained are reportedly indicative of a possible lightning strike. Class C damage is reported.
2. **Environmental:** (Hail x-2) While maneuvering to avoid thunderstorms, the UAS lost 5,000 feet of altitude and experienced a link hit. The UAS returned to base immediately. Post landing inspection revealed extensive composite skin damage as well as damage to the nose camera. For each aircraft, exposure to turbulent winds and suspected ice pellets resulted in major hail damage to the SATCOM antennae, as well as, minor damage to the synthetic aperture radar (SAR) radome, diagonal tails, and wings.

3. **Environmental:** (Unforecast winds) The UAS sustained damage subsequent to multiple landing attempts before final touchdown in unforecast high wind conditions. Post-landing inspection revealed damage to the right landing gear and the right diagonal tail.

Summary

Of the three categories, HE, MF, and environmental, HE is the leading cause of MQ-1C mishaps. Human error is totally preventable. Human error failures are often the end result of a series of errors, factors, and influences that lead or contribute to mishap occurrences.

The ability of leaders and Soldiers to identify hazards, determine control measures, and apply controls as spelled out in the risk management publication can turn HE into a memory for UAS operations. Leaders must provide guidance, training and oversight to reduce the probability of the occurrence of a mishap. Poor leadership, training and lack of maintaining a standard for acceptable performance leads to poor operational performance. A successful training program, enforced through command supervision and implementation of risk mitigation controls, sets high standards and produces high quality task completion. There is no place for short cuts in Army aviation operations. Command emphasis can and will reduce HE failures.

The second leading cause of MQ-1C mishaps is MF. These failures are being tracked and are being addressed by the field, the PM and OEM to reduce them. The last category, or third leading cause is environmental. Leaders can impact the environmental category through detailed planning, risk management and established guidance on operating in adverse conditions.

The MQ-1C GE UAS is a critical capability employed extensively in ongoing contingency operations. GE UAS extends the Warfighter's reach, enables maneuver out of contact with the enemy, and provides vital force protection and intelligence to the ground commander. To date, none of the mishaps have resulted in loss of life and commanders and senior leaders are managing known risks. ■

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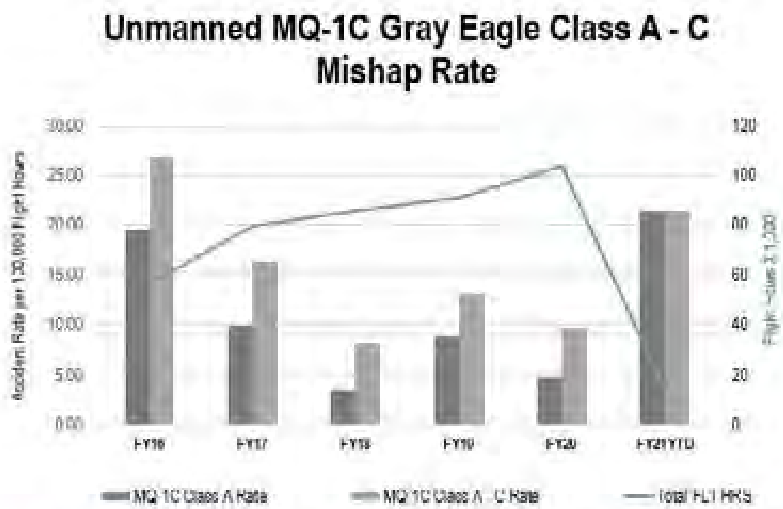

MQ-1C	2016	2017	2018	2019	2020	2021YTD
Class A Mishaps	11	8	3	8	5	3
Class A Mishap Rate	19.54	10.03	3.51	8.77	4.82	21.45
Class A – C Mishaps	15	16	7	12	10	3
Class A – C Mishap Rate	26.64	16.31	8.07	13.15	9.63	21.45
Total # of Flight Hours	56,304	79,728	85,362	91,262	103,795	13,989

as of 25 Nov 2020

Trend Comments

- Downward trend in mishaps FY19 – FY20
- FY20: 5 x MQ-1C Class A mishaps, rate 4.82
- FY20: 10 x Class A – C mishaps, rate 9.63

MQ-1C Trends to Monitor

- FY20 A-C mishaps:
  - 10 Total Mishaps (3 HE, 3 MF, 3 ENV, 1 UNK)
- Human Error causal factors:
  - 1 x Maintenance error
  - 1 x Frost on wings
  - 1 x Incorrect procedure

Additional Comments

- Positive downward trend in Gray Eagle mishaps following implementation of recommendations from the 2016 assessment team and implementation of engineering solutions to materiel failures

Mishap Briefs #97

Information based on preliminary reports of aircraft mishaps reported in December.

ROTARY WING

Cargo

H-47

G Model

- During conduct of a day helicopter aerial refuel (HAR) qualification training flight, while conducting the post HAR checklist steps, the cyclic trim switch was placed from manual to auto. The crew received an aft longitudinal cyclic trim (LCT) FAIL caution and saw that the aft LCT indicated it had programmed to the fully retracted position. The crew immediately slowed to 70 knots indicated airspeed (KIAS) (78 KIAS was calculated as maximum speed per the performance planning card) and flew back to the airport. The aircraft did not reflect any abnormal flight characteristics before or after decelerating to 70 KIAS. The aircraft weighed 42,000 pounds. The maintenance manual requires replacement of the aft vertical shaft when the aft LCT is fully retracted above 40,000 pounds gross weight and aircraft airspeed is above 78 KIAS. (Class C)

Utility

H-60

M Model

- The aircraft was conducting a multi-ship assault landing to a confined area helicopter landing zone (HLZ). The aircraft, after coming to a 25-30 foot hover, descended into the HLZ and contacted a building on the left side of the aircraft with its main rotor system. After contact, the aircrew landed the aircraft in the HLZ and completed an emergency engine shutdown without any injuries or further damage. Post-flight inspection revealed damage to all four main rotor blades. (Class C)

FIXED WING

EO-5

C Model

- The crew was on short final to the runway. When the flaps were set to 45 degrees the aircraft made an uncommanded left roll. The pilot on the controls returned the aircraft to level flight, set the flaps back to 25 degrees, and made a normal landing. The crew exited the runway for parking and observed a portion of the left flap was disconnected from the wing. (Class C)

Flightfax

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THE RECORD REVIEW

Upon signing into a new unit, aviation crewmembers (ACM) are required to turn-in their individual flight records folder (IFRF) according to Army Regulation (AR) 95-1, Flight Regulations. Standardization personnel will review the ACM's Centralized Aviation Flight Records System (CAFRS) flight training records and will assess the individual's qualifications, duty position, and tasks performed in the ACM's previous assignment. Based on this review, the commander may designate an appropriate readiness level (RL) for the ACM. Standardization personnel will document the RL on the ACM's Department of the Army (DA) Form 7122, Crew Member Training Record.

If a newly assigned ACM has not completed any portion of their previous aircrew training program (ATP) year's annual evaluation requirements, then those requirements must be completed prior to RL1 or RL2 designation. If the ACM has not flown within the preceding 180 days, then the ACM will be designated RL3.

Considerations

* To be designated RL1, based solely on a records check, an ACM must have - satisfactorily completed the following annual requirements within the previous ATP year:

o Annual standardization flight evaluation.

o Annual instrument flight evaluation (rated aviator only).

o Annual maintenance test pilot/maintenance examiner flight evaluation (rated aviator only, if required).

o Annual night vision goggle flight evaluation (if required).

o Annual written evaluation.

o Annual aircrew coordination training (ACT) sustainment module.

o Computer-based aircraft survivability equipment training and combat identification (as required).

o Aviation mission survivability (AMS) 2900- or 3900-series tasks (as required).

o Gunnery Tables (GT) according to Training Circular (TC) 3-04.3, Aviation Gunnery (as required).

o All other requirements designated by the commander to be completed as part of the ATP such as hypobaric refresher training, fixed wing simulator recurrent training.

o Completed a local area orientation according to local standard operating procedures (SOP).

o Met ACT sustainment requirements.

o If affected by a waiver or extension, must have completed all components of the annual proficiency and readiness test (APART) (written and hands-on) within the preceding 24 months to be designated RL1.

5 Questions

1. What circular establishes requirements for RL1 based on Gunnery Tables?
2. A newly assigned ACM hasn't flown in the past 180 days, what RL is the ACM? 1, 2, or 3?
3. An ACM can be designated RL1 solely based on a records check. True/ False?
4. Can a commander designate an ACM to other than RL1 after a CAFRS record review? Yes/ No?
5. What is the IFRF?

STACOM Message 21-01

Flight Reference Cards (FRC) Implementation

This STACOM establishes implementation guidance for the use of Flight Reference Cards (FRC) to be used in conjunction with the Emergency Response Method found in shared rotary wing task 1070, Respond to Emergencies, published in the Aircrew Training Manuals (ATM). This implementation guidance is not applicable to UH-72, Fixed Wing, and Unmanned Aerial System (UAS) communities. This message is applicable to the release of the emergency procedures portion of the checklist "Book 2" only. "Book 1", containing normal and detailed checklist procedures, will be released at a later date TBD.

TRAINING REQUIREMENTS: Unit Standardization personnel will self-start and initiate the training requirements listed in this STACOM for their units. Prior to initiating training, units must download the training package, possess the needed quantity of printed FRC (1 per ACM completing this training), associated FRC Divider Kits (TB 1-1500-1), and current operator's manuals (in digital or print format).

Academic Training: Academic training will be completed by all Aircrew Members (ACM) led by unit standardization personnel. Prior to administering the training, all trainers will familiarize themselves with the updated emergency procedures, FRC, and associated training package. All ACM shall review their corresponding Chapter 9s before implementation, as some emergency procedures have changed.

This training involves an overview of the FRC as well as practical exercises (PE) for each airframe. There are 5 EPs from each FRC section (Warning/Caution/Advisories/Mission Equipment) which will familiarize the ACM with the card design and how to apply it. ACM will only complete the PE for their airframe. It is recommended this training be conducted in a classroom utilizing audio/visual equipment to display the simulated faults, and application of the FRC.

The training package can be accessed from the link below or by navigating to the Directorate of Training and Doctrine (DOTD) Flight Training Branch page on AKO2.

FRC Implementation Training Package

Flight training: The FRCs work in concert with the Emergency Response Method (FADEC-F) providing ACM a structure to systematically respond to emergencies. To properly utilize FRCs, the ACM will use FADEC-F during the associated emergency procedure.

All RCM will conduct a block of instruction in their corresponding airframe by an SP/IP. The flight simulator is the preferred method for completing this training since it allows for a controlled environment while completing the selected emergency procedures outlined in the attachments. Units that are deployed or have an approved exclusion from SFTS requirements may complete the flight training in the aircraft, this approval is delegated to the Brigade Commander (O-6)/SAAO/Director. Those units that complete the training in the aircraft must ensure the selected EPs can be performed in the aircraft (reference the appropriate ATM). The RCM will complete a minimum of one iteration of each EP listed in the corresponding FRC EP list (see attachments). This training is based on proficiency and not time, complete additional iterations as needed to ensure the ACM fully understands and correctly utilizes the FRC. The

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