Flightfax

ARMY AVIATION RISK-MANAGEMENT INFORMATION

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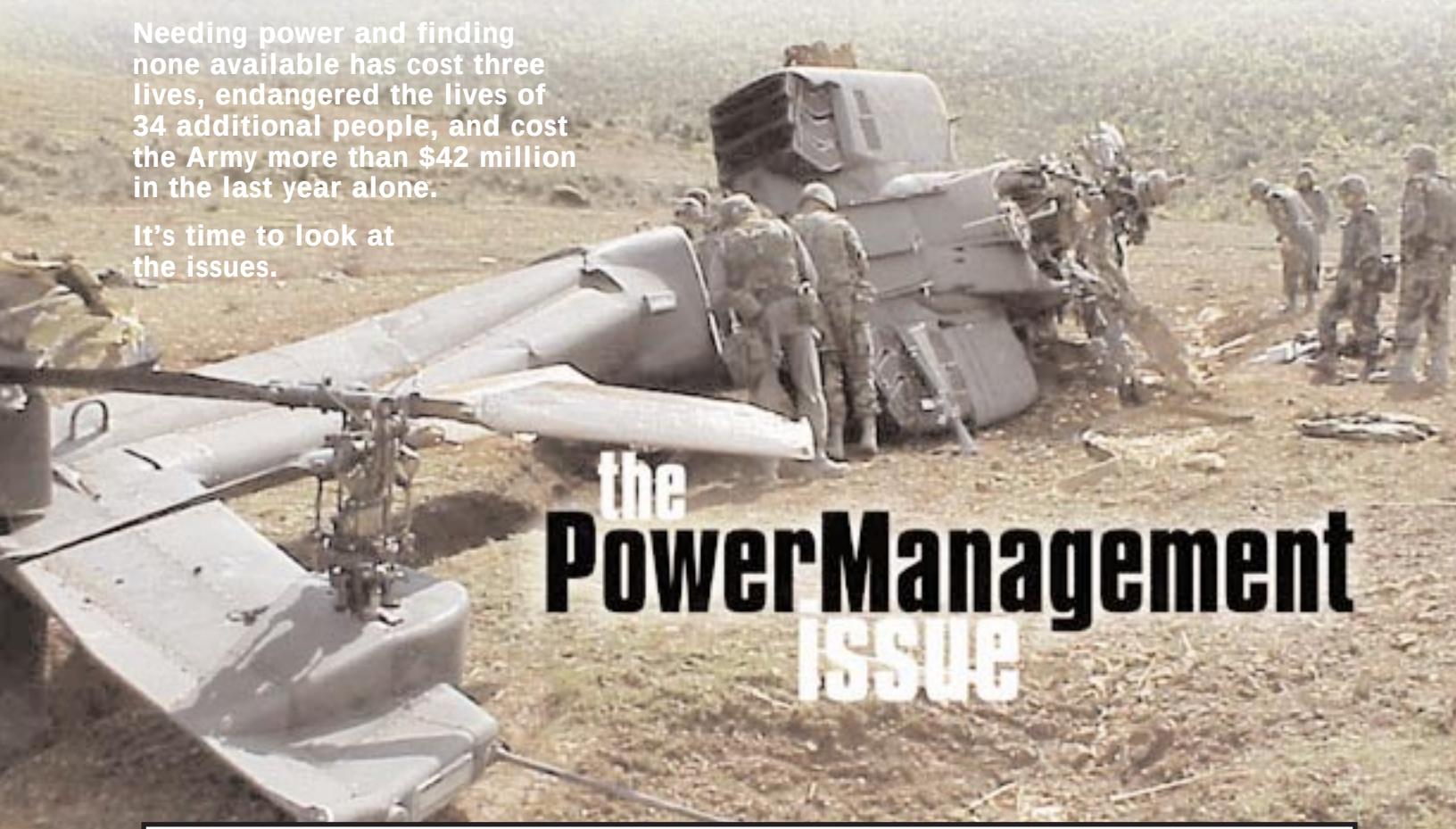


Needing power and finding none available has cost three lives, endangered the lives of 34 additional people, and cost the Army more than $42 million in the last year alone.

It's time to look at the issues.

the PowerManagement ISSUE

DASAF Safety Alert: Power Management

As a result of a number of recent Class A aviation accident investigations throughout the Army, U.S. Army Safety Center (USASC) personnel have noticed an increased number of mishaps caused by a lack of proper aircraft power-management procedures. Army aviators have become conditioned to the benefits of seemingly unlimited power from modern multi-engine aircraft often operated at low pressure/density altitudes and temperatures.

An organization may find itself deployed to an area very environmentally different from home base, operating in both high pressure/density altitudes and temperatures. These conditions, along with the high gross weights associated with many mission profiles, may result in less power available to the aircrew. The process of confirming power requirements with power available requires continual awareness and constant performance planning. Aircraft performance is predictable for any given environmental condition provided the planning data is accurately calculated and applied through appropriate power checks. However, performance planning is not enough. Aviators must also understand exactly how power-limited aircraft will perform during all phases of the assigned mission.

Training is the key to success in preventing mishaps involving power-management procedures. Instructor pilots and unit trainers need to emphasize the importance of proper aircraft performance planning as well as the application of that data to the mission. Aviators brought up on the latest generation aircraft must be made aware of the limitations of the aircraft they are operating. In the end, it is incumbent upon leaders to ensure timely, effective training and rigorous enforcement of standards.

—BG Gene M. LaCoste, Director of Army Safety

It was a beautiful, sunny day in the tropics. Hot? Yes! Humid? Yes! Boring? No, especially since the mission was detached from the proverbial "flagpole." With little command supervision and an inexperienced company commander on site, it was easy to bend the rules a bit. Commanders and pilots know that without appropriate supervision some aviators will take unnecessary risks for one simple reason: they can do it and not get caught. Unfortunately for this crew, their lack of professionalism and self-discipline caught them in the worst way imaginable.

The UH-60L maintenance test flight mission was a routine one—routine missions being the ones that cause so many accidents. The routine portion of the mission went just fine. The unauthorized portion that followed resulted in the deaths of two innocent people.

Have you ever been tempted to do a 60-degree bank angle turn? Probably. After all, there is a certain exhilaration to it. Plus, you're an aviator—chosen because you're willing to accept the risks of flying, and high bank angle turns just happen to be one of the more fun risks. It was no different for this crew, an ME and an IP. In spite of their considerable experience, this crew was not immune to power-management mistakes.

During the unauthorized portion of the flight and while seeking a little thrill, the pilots executed a high bank angle turn to the right at 100 feet above the highest obstacle (AHO). Not a problem, right? Wrong. It was a very big problem in this case. On a very hot day with low-pressure altitude (tropics) and a heavy aircraft (extra fuel tank on board), a high bank angle turn was not a good choice. Whether it was compressibility effects, retreating blade stall, or just plain exceeding power available (RPM decrease), the aircraft shuddered violently, the nose pitched up, the aircraft rolled left, and then it descended 100 feet to make an incredibly high-G impact into a densely wooded area.

When the thrill ride was over, two innocent people were dead, a $6 million aircraft was a mangled mess, and the high cost of this experienced crew's power-management error was readily apparent.

Lessons Learned:

■ **Experience:** Even experienced aviators are not immune to the effects of power-management mistakes. With a combined total of more than 2700 hours, the ME and IP piloting this aircraft failed to manage the power required to conduct this maneuver.

■ **Load Factor:** Computing a performance planning card (PPC) only tells how much power is available; it does not tell what the maximum power the crew is going to ask from the aircraft will be.

Unless you forecast *how* making turns increases power required, you really don't know *what* you will require from the aircraft. For example, a 30-degree bank requires an additional 15.4 percent power over cruise power to maintain altitude and speed. A 60-degree bank takes 100 percent more power. This must be considered before you can know whether you really have the power to do a maneuver.

■ **Retreating Blade Stall:** A quick look at Chapter 5 of the UH-60 -10 reveals that given a mildly hot day of 30°C (86°F) with an aircraft at 20,000 pounds at a pressure altitude of 0 feet while cruising at 100 KIAS, blade stall will occur somewhere near 52 degrees of bank angle. These are not an uncommon set of parameters, but frequently we fail to check this in Chapter 5.

The crew lived; in fact, they walked away from the mangled mess—a testament to the UH-60's crashworthiness. But a power-management error and a serious lack of professionalism and self-discipline resulted in these pilots killing two innocent people. With their careers destroyed and personal lives shattered, every day they will have to face the fatal consequences of their actions. □

Trying to Make Something Out of Nothing

The accident AH-64 was in a flight of six, conducting a simulated deep attack. The mission called for a long route at night, moving to attack by fire (ABF) positions. The aircraft were laden with armament and extended-range fuel system (ERFS) tanks. Performance planning indicated that the aircraft with 701C engines would have marginal hover power at the ABF positions, and those with 701s would exceed power available.

Instead of changing the aircraft takeoff weight, the command decided to identify the risk and mitigate it through controls. The command identified that some of the aircraft would not have the power to hover in the ABF and recognized that the associated risk of losing an aircraft and crew demanded some type of control measures. The commander implemented an in-flight power check prior to reaching the ABF positions to determine the ability of the aircraft to hover. Good idea? Not necessarily.

OGE hover power checks are conducted IGE instead of OGE for one reason: to mitigate the risk of falling out the sky. If you had to check OGE hover power at OGE height, you may run out of power on the way, potentially placing yourself in an emergency situation. However, for METT-T reasons, the AH-64s were to conduct an in-flight hover power check at a high hover near their ABF positions.

The potential to run out of power during the check was clear, and the command knew it. Realizing that residual risk would remain following application of their control (the hover check at the ABF positions), the command decided to modify the control to mitigate the residual risk further. The decision was made that, just prior to entering the temperature associated with TGT limiting, the pilots would execute a go-around to burn off more fuel. The power check would be done at a height not less than 200 feet AGL, giving altitude to accelerate back into effective translational lift (ETL). This would be repeated until they were light enough to conduct the hover in the ABF positions.

Unfortunately, the control broke down for the accident aircraft. The flight approached their positions and began to decelerate. The mishap aircraft crew slowed to about 20 knots, at which point they experienced a loss of rotor RPM with audio. The RPM warning extinguished as the PI reduced collective and applied forward cyclic to gain forward speed. It was at this point that the PI was forced to switch controls with the PC due to a pilot night vision system (PNVS) failure. Again, the RPM warnings went off immediately after transfer of the controls. Now the PC was trying to save the aircraft and crew.

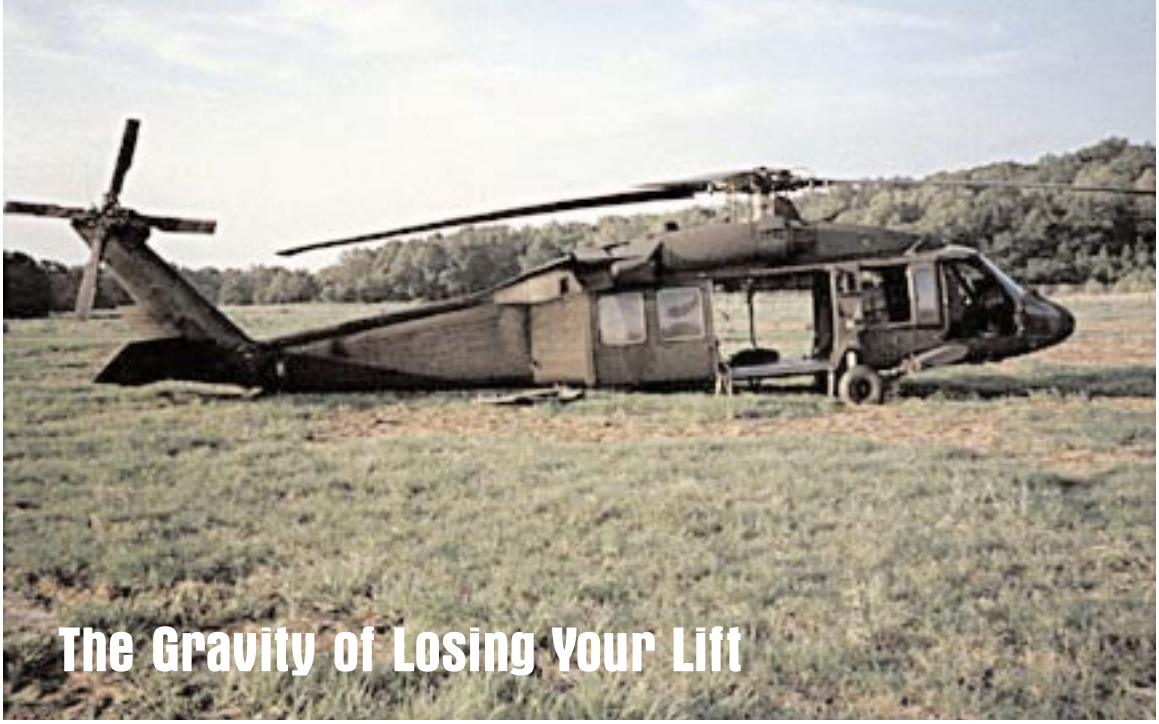
The PC executed the appropriate recovery maneuvers, but again the RPM warnings sounded. The PC decided to attempt a controlled landing in a clear field. At approximately 25 feet AGL and less than 30 knots airspeed, the nose of the aircraft abruptly turned 90 degrees to the right and the left main gear struck the ground. The aircraft rolled left, disintegrating the rotor system upon ground contact. When the aircraft came to rest, it was near inverted. The engines finally quit from sand ingestion and fuel starvation. Both pilots walked away with minor injuries.

This scenario represents a clear example of exceeding power available. Even worse, the pilots had calculated that they needed 94 percent for a hover at the ABF positions, yet they only had 85 percent available. Trying to make something out of nothing cost the Army a $15.5 million aircraft and left us with more lessons learned from power-management errors.

Lessons Learned

■ **Don't underestimate the risk of low-power margin, or in this case, no-power margin.** These were common missions with relatively benign events. Why would it turn into an accident? In essence, there was no room for error built in. Once you get to the limit of power in a hover check, you are either in an emergency situation or not. No room for error. A margin of safety could be applied to the go/no-go TGT criteria set by the command; that is something below TGT limiting.

■ **Don't underestimate the wind direction and speed in any aircraft.** As the crew started their deceleration to get below ETL, do you think their perception of speed was influenced by the 24 knot tailwind they were in? Read the article "When OGE Hover Power is Required—And You Didn't Even Know It" featured in this issue of *Flightfax* to understand how it was involved. □



The Gravity of Losing Your Lift

We talk power all the time: power available, power required, power margin, hover power. But ability to lift is something less understood. Lift created by the rotor is the only thing keeping the aircraft from falling out of the sky, and although it is inextricably linked to power, there are conditions more governed by the ability of the rotor to produce lift.

Settling with power, or the vortex ring state, is such a case where the disruption of airflow reduces lift even when power is applied. The crew of a UH-60 with 13 soldiers on board found out too well how this loss of lift can ruin their day.

The crew was conducting one of the most hazardous missions: a demonstration for holiday gatherers. The soldiers on board were to demonstrate the Fast Rope Insertion/Extraction System (FRIES) and Special Patrol Insertion/Extraction System (SPIES) for a crowd of family and friends. Before the actual demonstration, the accident aircraft, weighing only about 15,500 pounds (light by comparison), came to a 500-foot hover. The pilot was unable to make contact with the ground crew timing the event, so he cleared his line of sight by executing a high hover.

After an unsuccessful communications check, the pilot began a descent to return to his IGE hover. The descent, originally planned for 100 feet per minute, accelerated to 300 feet per minute. At approximately 150 feet AGL, the aircraft began shuddering and increased its descent rate with the application of power. The aircraft initially impacted in a slightly nose up, right side low attitude and bounced back into the air where the crew regained control and landed the aircraft. The aircraft sustained major structural damage; fortunately, the passengers reported only minor injuries.

The pilot had entered settling-with-power conditions without realizing it. The vortex-ring state began to interfere with the lift production of the blades; hence the shuddering from disturbed air over the blades. Application of power increased the vortices produced at the trailing edge of each blade, exacerbating the situation. This easily could have resulted in 13 deaths. Luckily, it didn't.

Lessons Learned

■ **Settling with power conditions are easy to encounter.** FM 1-203 states that the conditions conducive to settling with power are a vertical or near-vertical descent of at least 300 feet per minute and low forward speed. The rotor system must be using some of the available power (20 to 100 percent) with insufficient power to retard the sink rate. These conditions are common to downwind approaches, formation approaches, steep approaches, NOE, mask and remask operations, and OGE hovering.

■ **Experience doesn't always prevent an accident.** The PC and PI had a combined total of more than 4,500 flight hours. But all their combined experience didn't prevent them from making a power-management mistake.

■ **Extra power may not stop your descent rate.** This aircraft was relatively light at a low-pressure altitude and had 100-percent power available. The extra power that should have retarded their descent didn't. If you're going to put yourself in the conditions conducive to settling with power, realize that the extra power available may not be enough to stop your descent rate.

—CPT Stace W. Garrett, Chief, Utility Branch, U.S. Army Safety Center, DSN 558-9853, 334-255-9853, E-mail: garretts@safety-emh1.army.mil

"Jettison" Your Old Mindset

"Why didn't they punch off their external stores?"

This was an interesting question posed following a recent settling-with-power accident. Some would speculate that pilots are wary of punching off external loads if confronted with a power-critical situation because they think it's automatically, at least, a Class C accident based on the potential damage cost to the jettisoned equipment. And who wants an accident on their command or pilot record; someone might view it as a reason for not giving the pilot a top block on an evaluation report. Assuming that there is at least some validity in this speculation, it's important that pilots understand that jettisoning equipment is not an automatic accident.

Before getting to the decision moment for jettisoning anything, the first line of defense is pre-mission planning. Avoiding power-critical situations by understanding power margin—difference between power required and power available—at every point in the flight makes this a moot discussion. The second line of defense is the emergency procedures and recovery techniques that all pilots should know without hesitation; for example, knowing the symptoms of settling with power and how to recover. If for some reason, the emergency procedures and recovery techniques can't or don't resolve the power-critical situation, then it's time to think about increasing the power margin in some manner. That usually means jettisoning weight.

There is no question that getting rid of weight is a prudent thing to do to save an aircraft and crew. No one should be concerned about some gunpowder, fuel, or composite material if keeping it means risking the lives of those on board or destroying the aircraft. Whether it's settling with power or decreasing rotor RPM, less weight means more power margin. As weight drops, less power is required, and therefore more margin is available to get out of a power-critical situation. Bottom line is that jettisoning slingloads, weapon stores, and fuel tanks is **not** automatically an accident.

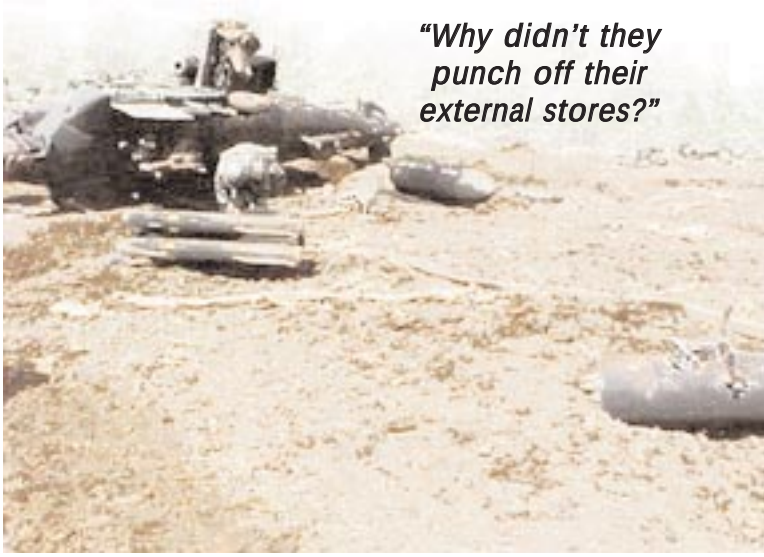
AR 385-40: *Accident Reporting and Records* (paragraph 2-11.b.(9)(f) states that intentional in-flight controlled jettison or release of mission essential aircraft equipment/stores that are not essential to flight—for example, canopies, doors, drag chutes, hatches, life rafts, auxiliary fuel tanks, missiles, drones, rockets, non-nuclear munitions, and externally carried equipment—are not included in aircraft accident costs. It is relatively clear that if presented with a power-critical situation, the regulation gives a pilot license to punch off weight and not call it an accident.

However, there is a stipulation. The same section states that there must be no injury or reportable damage to the aircraft or other property. So, if a crew falls within these guidelines and needs more power to continue flight, is jettisoning the right thing to do? Not always.

Pilots should not be afraid to dispose of weight if it means saving the aircraft and crew, but a recent accident highlights another issue to consider. The accident that prompted this discussion involved an AH-64 that decelerated to a high OGE hover with a tailwind. The aircraft was laden with full racks of munitions and an ERFS tank that was about one quarter full. As the vibrations began to mount because of settling with power, the aircraft had already lost so much altitude that the standard recovery technique (gain airspeed) would have been futile.

The first two lines of defense broke down. In pre-mission planning, the crew did not foresee this power requirement and didn't recognize the settling-with-power situation fast enough to execute a recovery. Obviously, the only thing available to the crew was jettisoning their external loads of fuel and real munitions. Jettisoning the load seemed logical, but it wasn't a good idea in this situation. Fortunately, the crew knew it.

The aircraft crashed violently, causing total destruction of another $15.5 million aircraft. However, the two pilots received



only minor injuries—another testament to the crashworthiness built into the aircraft. So why didn't the pilots save the aircraft by jettisoning the loads? They would have had time to jettison the loads, but thought about it and decided against it.

The power-critical situation occurred over a sloped area populated with parked aircraft and ground crews. In a split-second risk assessment, the crew decided that the jettisoned racks might roll down into the ground crews and parked aircraft and explode to cause even greater damage and potential injuries. So the crew rode it in with the hopes that only their aircraft would be harmed. Their accurate risk assessment prevented a bad situation from becoming worse.

While it's easy to see and understand that jettisoning isn't always a viable option, crews need to understand that in some cases it is an acceptable option that doesn't automatically result in having an accident appear on their flight records.

Creating a mindset that jettisoning may be an option can be reinforced by establishing a standard procedure in the cockpit that is briefed before every mission. If single-engine capability doesn't exist, it might be prudent during takeoffs and landings to have the pilot not on the controls place a hand near the jettison switch and announce it. This automatically makes the crew aware that they are entering a flight regime where they do not have single-engine capability and might need to eject weight. The first two lines of defense are ineffective in a single-engine-failure situation, so jettisoning should be on the crew's mind.

If you happen to be one of those who thinks that getting rid of extra weight is automatically an accident, then it's time for you to jettison your old mindset. It isn't, but it could be. Use your pre-mission planning and standard emergency procedure and recovery techniques to avoid the decision to jettison. If it's your last option, don't hesitate to make the decision—just be careful not to cause more harm than good.

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When OGE Hover Power is Required—And You Don't Even Know It

Place yourself in the following situation, and see if you can describe what has aerodynamically happened to make this aircraft crash.

It's a great day for flying. The sky is clear, the air is stable, but winds are strong. Your aircraft is on long final for a landing to a tactical assembly area on a heading of 080. The TAC tower informs you that winds are 240 at 15 gusting to 25, but you've been landing 080 the entire exercise. You've just completed a successful training mission where the aircraft was at near gross weight for the entire mission. Since you were operating at high gross weights, you were very meticulous about your performance planning. You noted that OGE hover power was not available, and your IGE hover power was limited at landing to 25 feet AGL.

As you begin your landing to the strip, you realize you're landing downwind—but you are in a dual-engine aircraft. Even though you have a small power margin, you don't foresee a problem as long as you land with some forward airspeed. You pick up a constant, normal angle of approach. At about 200 feet AGL, you continue to slow your airspeed and begin to focus on your rate of closure. You know to ensure that your rate of closure is appropriate for the conditions, so you decide that a 10- to 15-knot ground speed at landing is appropriate.

At about 100 feet AGL, you notice a slight shuddering of the aircraft and 25 KIAS on the dial, but your ground speed is still fast. However, you still feel like you're on track to touch down at your desired speed. At 75 feet the shuddering becomes more prominent, but you're focused outside and still decelerating to make a smooth landing. Immediately, you begin to drop. You try to arrest the descent with more power, but the RPM starts to bleed off. At this point, you still have a ground speed of 20 knots. Your aircraft lands hard, the rotor horn blaring. So what happened?

The aircraft did not have OGE hover power when it needed it. But why did an aircraft in these conditions need OGE hover power if it never hovered?

FM 1-203: *Fundamentals of Flight* says that "hovering is when a helicopter maintains a **constant position over a selected point,** usually a few feet above the ground." Based on this definition, the aircraft in the above situation

was not hovering because it did not maintain a position over the ground. However, aerodynamically, the aircraft was hovering at the point where the ground speed equaled the tailwind speed. That means that the air the rotor system was using for lift was moving at the same speed as the fuselage. The airflow pattern while the aircraft moved in concert with the tailwind was the same as the airflow pattern for an aircraft hovering over a point on the ground in a no-wind condition. The manual definition of a hover assumes this no-wind condition.

In the scenario, at about 75 feet AGL when the shuddering began, the aircraft was below ETL even though the ground speed was about 20 knots. The relative speed of the aircraft through the air would have been no more than 5 knots. Aerodynamically, the pilot was effectively OGE, requiring OGE hover power. The pilot had determined that a 25-foot IGE hover was the maximum power available, and without realizing it, he placed the aircraft in a 75-foot OGE hover.

This phenomenon is not isolated to landing an aircraft with a tailwind. It's prevalent when taking off, coming to a hover for an attack/support by fire position, landing to a pinnacle, and in-close-to-the-ground low-speed flight like NOE above lightly vegetated forests. In fact, on a normal takeoff, you could actually fly into an OGE hover power requirement. How could this be if you do a hover power check and have the 10 percent needed for a normal takeoff?

Consider an extreme case. Let's say you have a 30-knot tailwind on takeoff and you have predicted only enough power to hover at 25 feet (not OGE). You conduct your hover-power check, and it's less than the predicted hover torque. When lifting off the ground, the tailwind places the aircraft through ETL (the aircraft is over a point and the air flows through the rotor at 30 knots). While climbing and accelerating ground speed in this normal takeoff, you actually are leaving the positive effects of ETL as you catch up to the tailwind. At 25 feet, you notice you are pulling maximum torque available just to maintain altitude, yet you have a ground speed of 30 knots. If you pull more power to accelerate, you will descend. If you have ever executed a downwind departure with high power margin, you have undoubtedly seen the effects of catching up to the tailwind; that is, a positive climb rate on takeoff, then a large decrease in climb rate as the aircraft matches speed with the tailwind, followed by a positive climb as it passes through ETL again.

Although downwind takeoffs and landings are extremely dangerous with a low power margin or in a single-engine failure mode, the opposite is also true. Headwinds can help significantly by increasing the time you're in ETL during a landing or takeoff.

The bottom line is that a PPC cannot tell you everything about the performance of your aircraft. In Chapter 7 of the UH-60 -10 under the GENERAL section, it states, "In addition to the presented data, **your judgment and experience will be necessary** to accurately obtain performance under a given set of circumstances." This article presents only one of those circumstances that the performance charts don't explicitly evaluate. And as the Army creates heavier payloads and operates at higher altitudes, each of us should be conscious of power margin needs at every point in flight.

If you're a pilot in the dual-engine community that shies away from calculating the effects of wind direction and speed during maneuvers, perhaps you should take a lesson from the single-engine community—a community not prone to power-management errors because they constantly operate at low power margins. They are bred to be cognizant of wind and how it affects the rotor aerodynamics during every maneuver. It's habit to them, and it should be habit for you as well. You may be frequently flying with large power margins, but the time will come when you have to fly near gross weight—and the habits that you've learned will be the habits you apply.

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Controlling power-management errors

The trend over the last few months definitely suggests that power-management errors are occurring more frequently. With a rise in deployments and the operational need to carry more weight, the potential for running out of power and lift capability has increased.

As a commander, you should effectively risk manage this identified hazard by implementing controls. The following controls are presented as ideas to prompt thinking and discussion.

FYI

In Production: A Power Management Video

The Army Safety Center has teamed with several other agencies to address the problem of power management. Through an accident recreation you will hear lessons learned delivered by the pilot in command and safety professionals who investigated the mishap. Areas addressed are:

- Power management
- Crew coordination and
- Risk management.

When it's ready we'll announce it in *Flightfax* and on the Army Safety website http://safety.army.mil, along with instructions on how to obtain a copy.

Reference PIN number 711267.

■ *Simulators.*

If you have a simulator, you have one of the most powerful tools to stop this rash of power-management accidents. Although a simulator cannot simulate settling with power, compressibility, or retreating blade stall, it can be used to stay out of those conditions. Ask yourself the following questions:

- Do I have a formal program that makes the simulator actually simulate a real flight? This takes some policies, but it would undoubtedly result in better-trained pilots.
- Do I enforce proper habits in the simulator? For example, is the mission fully planned, is the PPC completed, are winds considered in all maneuvers regardless of weight?
- Do I help my pilots train for the worst conditions in the least risky environments? Have pilots ***frequently*** conduct simulator flights at ***high gross weights***, on ***hot days***, and at ***high altitudes***. This makes them constantly think about the effects of power margin. They'll learn to finesse the aircraft.
- Do I have my pilots demonstrate the effects of and show recovery from settling with power, compressibility, retreating blade stall, and especially, the effects of high-load factors (steep turns)?
- Do I have my pilots show proficiency in the ability to jettison external stores?

If you want to help your pilots stay away from deadly power-management problems, the answer should be yes to each of these questions.

■ *Jettisoning.*

All too often, pilots and commanders rely on the fact that jettisoning will allow the pilot to gain a higher power margin when necessary. There are two problems with this. First is that power-critical moments tend to come while close to the ground, not allowing enough time to make the decision. Of six power-management accidents in the past few months, five of the aircraft had jettisonable stores and all of the accidents happened close to ground. Second, we do not train to be cognizant of the pertinent times that we may need to jettison stores. Here are some areas to consider:

- Check every pilot in the simulator with a no-notice emergency that requires jettisoning. For example, initiate a single-engine failure while at a 50-foot hover or while landing to a point with no single-engine capability.
- During the crew brief, have the crew discuss the times at which it may become necessary to jettison the stores.
- Consider an SOP that makes the pilot not on the controls place a hand next to the jettison switch and announce that they are ready for a jettison command if necessary. This could be a requirement any time power may become a problem such as exceeding power available on takeoff or landing, or during a single-engine failure, or settling with power.

■ *Extended-range fuel system.*

ERFS tanks are **not** crashworthy! The atomization of fuel, combined with sparks from crunching metal or hot exhaust, is a recipe for destruction. In the six recent power-management accidents, ERFS was in use in five. Luckily, only one of the aircraft had a fire associated with the tanks, and that did not end in injuries or fatalities.

An assessment of ERFS use should include not only the risk of rupture but also should address the reduced power margins that follow. Is the mission really worth being exposed to this hazard? Is it really necessary to fly with ERFS to accomplish this mission? Recent accidents suggest that commanders are answering "yes" quite often.

■ *Risk assessment sheets.*

The risk assessment sheet has become a great way to assess the cumulative risk of recurring factors that affect aviation safety.

Help pilots think about power management by prompting them on the risk assessment sheets. Pilots are overburdened with requirements (all of which are necessary), but the best way to help them is to prompt them to think of things they might have missed. The risk assessment sheet does that. However, the risk associated with low-power margin has not been assessed on any risk assessments I've seen. In fact, the first time I saw it was on a commercial airline risk assessment sheet.

If you include a low-power margin risk factor, you might want to ensure that pilots use the worst-case scenario that comes throughout the flight, including power expected to conduct their turns. What value do you assign a low-power margin risk? As commanders, you have the freedom to assess the risk using your best judgment, but consider how much room for error a 3- or 4-percent power margin leaves during some maneuvers.

■ *Know aircraft limits.*

Power-management problems can be eliminated with a good knowledge of the aircraft's limits. A PPC provides a good understanding, but not the full picture. Obviously, the first steps in knowing the power limitations in varying conditions is to do the PPC regularly and understand the meaning of the numbers.

Leaders and mission briefers can help develop a better understanding of PPC results by asking pilots about power requirements while giving them their mission brief. Ask to see what they have computed if the aircraft is relatively heavy. Knowing the numbers is not enough; understanding and applying them are critical.

Only through a thorough knowledge of the aerodynamics of maneuvers, coupled with good knowledge of the PPC, can a pilot make an effective decision when presented with a power-critical situation. Understanding how wind, descent rate, temperature, turbulence, and other factors influence regular maneuvers is one of the best defenses against this hazard.

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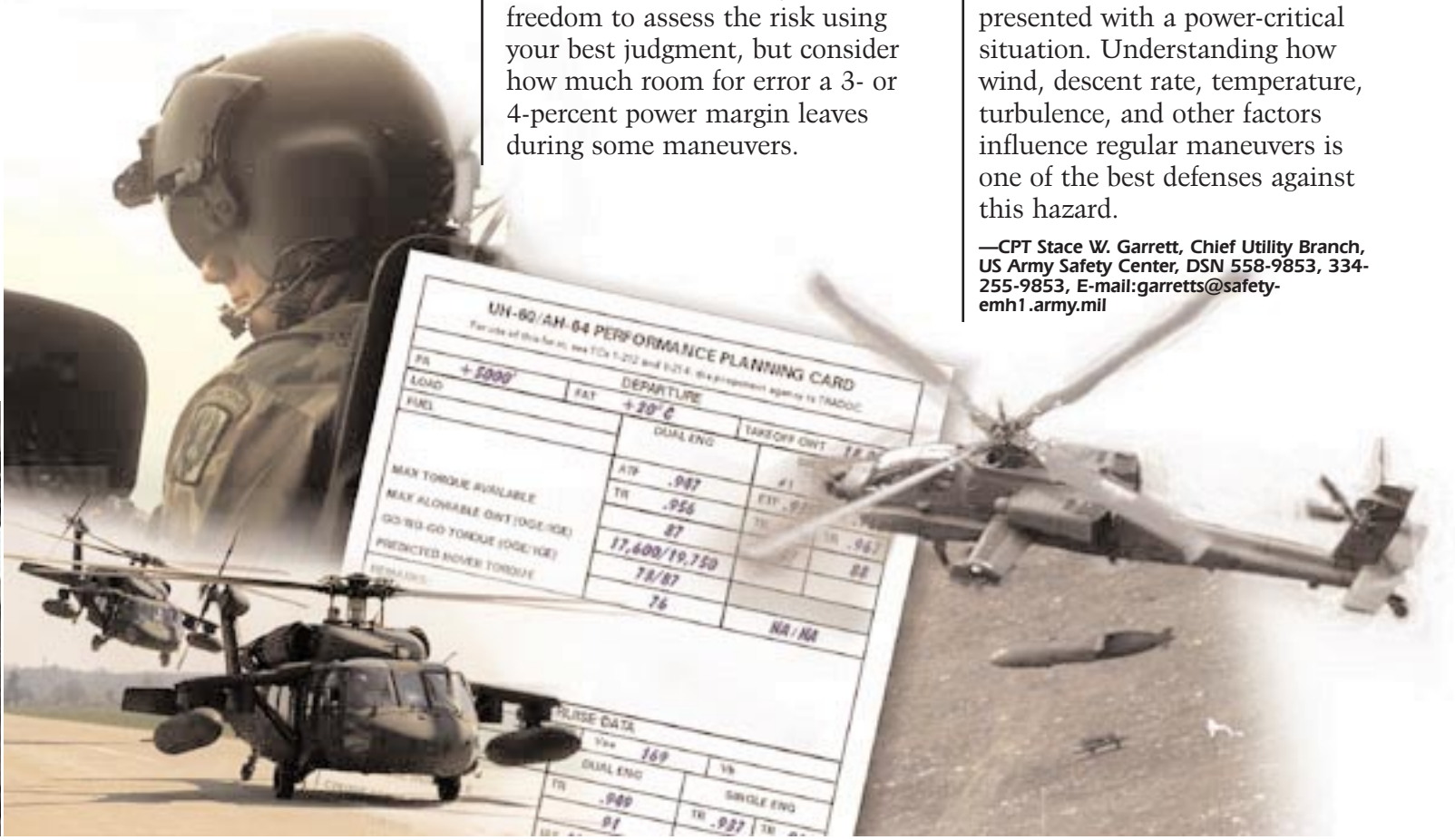

Power Management Jumble

Directions: Take a moment to answer the following 15 questions. The answer is jumbled in the questions and underlined. Un-jumble the answer and place in the spaces provided. Place the letter that corresponds to the numbered space in the quote.

Post the following question wherever pilots do risk assessments:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

of

25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

I'm about to do?

1. The objective of risk management is not to remove all the risk, but to ___ ___ ___ ___ (NELIITAME) unnecessary risk.

2. Specific hazards to terrain flight safety that must be considered include ___ ___ ___ ___ (YIACPLSH) hazards, ___ ___ ___ ___ (ARWEEHT) hazards, and human factors.

3. The addition of the relative wind and any induced flow is called ___ ___ ___ ___ (LTTUSAERN) relative wind.

4. The angle measured between the resultant relative wind and the chord line of the blade is the ___ ___ ___ ___ . (GLAEN FO KTAATC)

5. If a force enters into the rotor (by wind or control input), how many degrees later in rotation does the force really act (gyroscopic precession)? ___ ___ ___ ___ (ENNYTI) degrees.

6. In-ground effect increases rotor efficiency by almost ___ ___ ___ ___ %. (WYNETT)

7. For most helicopters, you effectively are out-of-ground effect at a height equal to 1 to 1¼ of the rotor ___ ___ ___ ___ . (RTEEDMIA)

8. In your helicopter, you are flying on a hot day at high altitude near your gross weight and at a little above cruise speed. You feel vibrations increase and the aircraft's nose suddenly pitches down and to the right. What effect did the advancing blade experience? ___ ___ ___ ___ ___ ___ ___ ___ (ITPBIESOSICLTMR)

9. In your helicopter, you are flying on a hot day at high altitude near your gross weight and at a little above cruise speed. The weather is slightly bumpy, but the vibrations start to increase. Your aircraft's nose suddenly pitches up and rolls left. What effect did the rotor system experience? ___ ___ ___ ___ ___ (GNIRTEETRA LAEBD ATLSL)

10. What condition is the only difference between retreating blade stall and compressibility effects? ___ ___ (PMR)

11. You are chalk 2 in a flight of five, shooting a downwind approach. You are in a hurry to land, and your approach is very steep. Your aircraft begins to vibrate, and it descends faster than you expect. With more power applied, the descent rate increases. What effect are you experiencing? ___ ___ ___ ___ ___ (LIGTTSNE HWTI WOEFP)

12. Settling with power is caused by the rotor system descending through its own ___ ___ ___ ___ (SOWHANDW).

13. For single-rotor system aircraft, if enough power is not available to break settling with power, the preferred method of recovery is increasing ___ ___ ___ ___ (ERDSIEAP). Hint: for tandem rotor aircraft, the preferred method is lateral cyclic movement.

14. You are flying at 100 kts and 50 feet AHO on the range, and approach a 90-degree turn. In order to maintain altitude and speed in the turn, what angle of bank are you most likely in if your power required is twice your cruise power? ___ ___ ___ ___ (TSXYI) Hint: 73° requires three times the power of cruise flight.

15. When doing your PPC, you calculate that the smallest power margin during your mission is 2%. You have looked at all parts of your flight, including the fact that the highest bank angle you expect is 30° (15% more power needed in the turn). Where is a good place that this risk can be assessed with the overall mission? ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ (IKRS EEASMSNSTS EHTSE)

AH-64 BUCS

The backup control system (BUCS) on the AH-64A and the enhanced backup control system (EBUCS) on the AH-64D Longbow have become synonymous with uncommanded flight control inputs, aircraft loss of control, and in general, demons in the Apache. Aviators fear the system, crew chiefs avoid it when possible, armament personnel loath the system, and maintenance officers are in awe of it. What is it about BUCS that instills this fear of the unknown?

BUCS DEFINED

The BUCS is an integrated electrical fly-by-wire emergency flight control system on all Apache helicopters, though it was disabled on the earlier models. The system itself was designed to be used only as an emergency backup to the primary hydro-mechanical flight controls. The system components were intended to require little or no maintenance. So, what is the mystery and why do we even have BUCS?

The BUCS was designed into the Apache as a way to meet specifications for ballistic tolerance. To have a redundant system meant the Apache could meet these requirements with a lighter weight primary flight control system. For example, instead of 3-inch diameter control tubes necessary to withstand a 12.5mm impact, much smaller control tubes were acceptable due to the redundant backup control system.

Therefore, the BUCS was designed as an integral part of the aircraft to make it more survivable in combat. Based on carefully established parameters, software, electrical, and mechanical features, BUCS engages in whichever axis fails and for whichever crew station is in control. The system may go into operation due to a jam, a severance, or a mistrack between crew station flight controls.

CLASS A ACCIDENT

A recent Apache accident involved a very senior standardization instructor pilot with some 4,500 hours of flight time. He found himself in an emergency situation, an unusual attitude, and with BUCS engaged suddenly in two axes—pitch and yaw. The DASE was disengaged in both axis, by design. He was unable to successfully land the aircraft, resulting in a Class A accident. The crew was lucky, escaping virtually without injury. Did BUCS work as advertised? If so, why couldn't a capable master aviator regain control of the aircraft?

THE "RED TEAM"

Questions from this accident and from other past incidents led the Deputy Chief of Staff for Logistics to charter a team of engineers and experts—a "Red Team"—to look at the entire Apache flight control system.

The team examined the AH-64 history, hydro-mechanical flight control system, and why the key decisions were made. Additionally, they analyzed mishap statistical data, examined BUCS, evaluated BUCS training, and reviewed all related critical components.

A REVIEW OF BUCS INCIDENTS

Early on in the Apache fielding, aviator mistrust of the BUCS, exacerbated by an incident at the aircraft plant involving inadvertent BUCS activation, led to a decision to inactivate BUCS on all Apache aircraft. This remained in effect until 1988 when the decision was reversed. All subsequent aircraft have a fully active BUCS system. Older BUCS-inactivated aircraft are currently going back to the plant for conversion to AH-64D Longbow aircraft with fully active EBUCS.

Since 1984 there have been some 59 instances of uncommanded Apache flight control inputs reported to Boeing (McDonnell Douglas), the Army Safety Center, or the Aviation and Missile Command. These range from simple kicks in the controls to "BUCS ON/BUCS fail" warning lights and uncommanded aircraft movements.

Causes of these inputs can be attributed to several different sources: digital augmentation and stabilization equipment computer (DASEC) inputs, heading and attitude reference system (HARS) input, mechanical failure (hydraulics contamination or servo-actuator), and the BUCS, both inadvertent activation and failure of the system to engage when needed.

Most occurrences involved warning lights only. Actual uncommanded flight inputs were rare and generally categorized as HARS or DASEC inputs, ranging from mild pedal kicks to complete hardovers in one axis. Of the 12 reported HARS/DASEC hardovers, only two aviators elected to disengage DASE channels as prescribed in the emergency procedures. The others continued to fight the controls. The improved –15 HARS has since significantly reduced this type of incident.

There were a few instances where the servo-actuators were affected by the stabilization augmentation system (SAS) sleeve. The SAS has a total of 20-percent authority (+/- 10 percent) in the roll axis and 30 percent in pitch. When the SAS sleeve assembly sticks to the servo-actuator, the SAS movement is transferred directly to the servo and gives feedback into the controls themselves.

There was one instance of BUCS failing to engage when needed. This occurred on a maintenance test flight when a shear pin actuating device (SPAD) broke, placing the aircraft into roll channel BUCS; however, a faulty micro-switch failed to actuate BUCS in that axis, rendering it out of control. This resulted in a Class A accident, a destroyed aircraft, and two serious injuries. There have been two instances, however, where BUCS was engaged during a jam and enabled the aircraft to be flown and safely landed. (The Israeli Air Force had two more.)

BUCS TRAINING

Based on the evidence, an interesting picture began to materialize. Training on BUCS had never been considered a critical task item. Accordingly, training is totally inadequate for everyone involved with BUCS aircraft, from the aircrew to the mechanic. For example, the aircraft qualification course (AQC) has a program of instruction (POI) of just 2.5 hours of academics for the entire

flight control system, 10 minutes of which is devoted to BUCS. There is no simulator or BUCS flight training. Though aircrews believe that BUCS activation enables complete control, transparent in the cockpit, that isn't the case. The aircraft has different handling characteristics in BUCS, with affected DASE channels disengaged and force trim either active or inactive. The time to realize this is not during an emergency in an unusual attitude. Additionally, BUCS does not "kick in" immediately. There is a 1- to 3-second built in delay (depending on type of engagement) to prevent a full hardover as BUCS engages.

All this is manageable, given proper training. The Apache Longbow crew trainer (LCT) simulator is presently the only device that will replicate "BUCS ON" flight. The AH-64 simulator does not. Additionally, classroom instruction is inadequate beyond AQC and throughout the maintenance officer and mechanics courses. Troubleshooting procedures are either inadequate or not understood. This lack of understanding BUCS maintenance can lead to mishandling of components and improper trouble-shooting, causing us to overlook potential problems in the system. Since it isn't activated until needed, these may go unnoticed for years.

Additional Problems

A recent safety-of-flight (SOF) message, SOF-AH64-99-02, requires that the linear variable digital transformers (LVDTs) be checked for voltage output. This is required on all AH-64 BUCS-active aircraft. The tolerances are very exact. Any LVDT out of tolerance must be adjusted and all eight voltage readings are to be recorded on the DA Form 2408-13-1. The LVDT is a critical BUCS component, providing control position data, through voltage readings, translated to the system. Improper adjustment or failure to properly record the voltages could lead to inaccurate control position interpretation by the system.

Just as any flight control system, it is absolutely essential that BUCS be maintained as intended. It is critical that we know how to troubleshoot problems. Maintainers must know the system.

So why not just inactivate BUCS as before? With BUCS inactivated, an integral part of the designed flight control system is inoperative, leaving the aircraft with a reduced-strength primary mechanical flight control system. The BUCS inputs are controlled through the HARS. These computations are always present, regardless of the BUCS status. Bottom line—aircraft survivability is decreased without BUCS.

As aircrews, we must understand our flight control systems, including BUCS. Maintainers, too, must fully comprehend the system. Components must be maintained within tolerances; controls must be properly rigged. The flight control system must be kept operational and internally clean. All are essential to a fully functional control system on such a complex aircraft.

Summary

The "Red Team" is currently exploring options, developing potential solutions, and making recommendations concerning fixes. Answers to the puzzle are on the way, and those answers lie in knowing, understanding, training, and maintaining an integral part of the aircraft flight control system.

—MAJ(P) Mark Robinson, Chief, Attack Branch, US Army Safety Center, DSN 558-1253, 334-255-1253, E-mail: robinsom@safety-emh1.army.mil

POV Fatalities through 30 Jul

FY99	FY98	5-yr Avg
99	96	91

HIGH-RISK PROFILE

Age & Rank: 19-23, E1-E4, O1, O2
Place: Two-lane rural roads
Time: Off-duty, 1100-0300
Friday & Saturday nights

TRENDS 1. No seatbelt or helmet 2. Too fast for conditions 3. Fatigue

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FY99 Aviation Accidents through 30 Jul

		Class A	Class B	Class C	Total
ACCIDENTS	Total Avn Acdts	16	9*	73	98
	Flight Acdt Rate	1.96	.98	6.99	9.93
RATE COMPARISON	FY99 vs. FY98	18 %	78 %	12.6 %	2.6 %
	FY99 vs. 5-yr avg	58 %	3.2 %	9.9 %	16.25 %
	Aviation Military Fatalities				13

*Class B downgraded to Class C

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