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Army Aircraft Safety Performance Review

FY 87 through FY 91

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Foreword

This report was prepared to provide aviation commanders, safety officers, aircrews, and maintenance personnel an overview of UH-60, OH-58D, AH-64, and MH/CH-47D safety performance for fiscal years 87 through 91. The report is in five sections. Section 1 describes overall Army aviation experience. Sections 2 through 5 provide overviews of the accident experience of each aircraft system along with synopses of selected Class A and B accidents. Note that these synopses do not necessarily reflect all factors contributing to the accident; they concentrate on the primary cause factor.

Users of this publication are encouraged to submit recommended changes and comments to improve the publication. Comments should be forwarded to Commander, U.S. Army Safety Center, ATTN: CSSC-PMA, Fort Rucker, AL 36362-5363.

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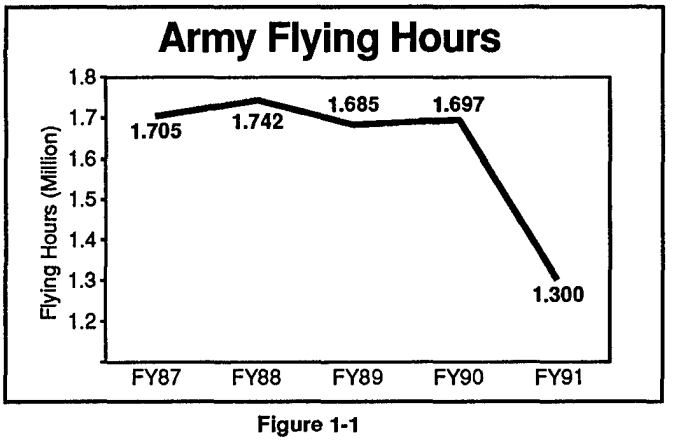
Section I

Armywide Aviation Experience

During the 5-year period of FY 87 through FY 91, the Army experienced 181 Class A flight accidents, 54 Class B accidents, and 366 Class C accidents. Figures 1-1 through 1-5 display Armywide performance during this period. The DOD accident classification criteria used to classify these accidents is shown at table 1-1.

These accidents resulted in destruction of 169 aircraft. There were 181 fatalities and 227 permanently disabling injuries to Army personnel. Damage costs exceeded $551 million and injury costs exceeded $97 million, for a total loss to the Army of more than $649 million, 169 aircraft, and 408 personnel. These losses roughly equate to losing the personnel of two aviation battalions and the aircraft of one and a half combat aviation brigades.



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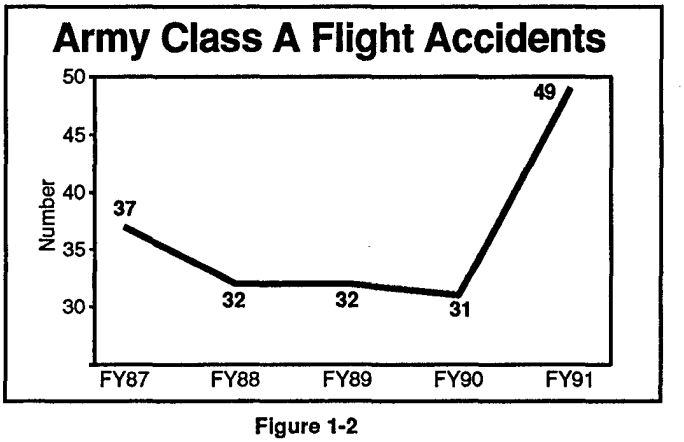

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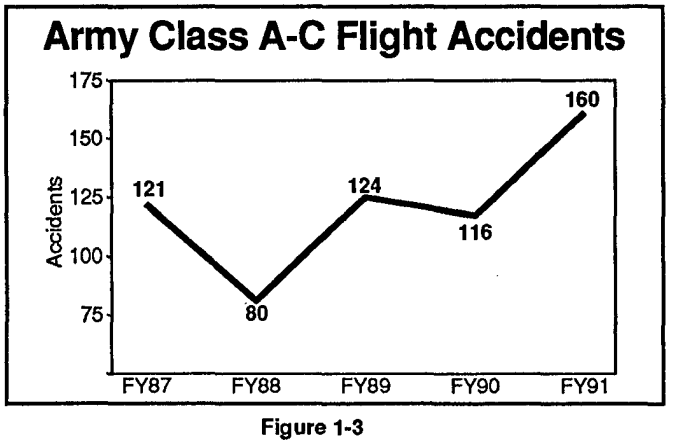

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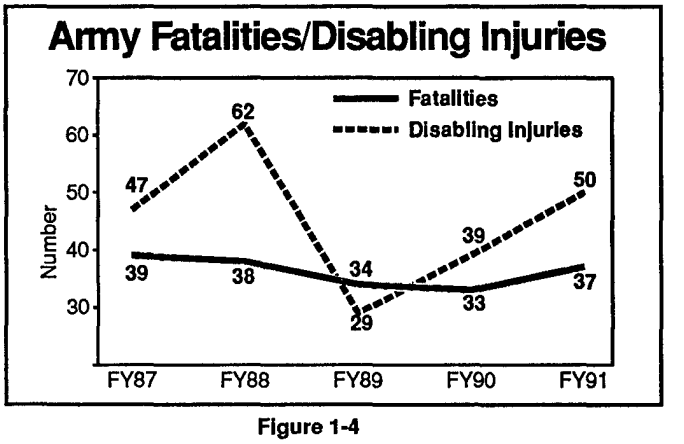

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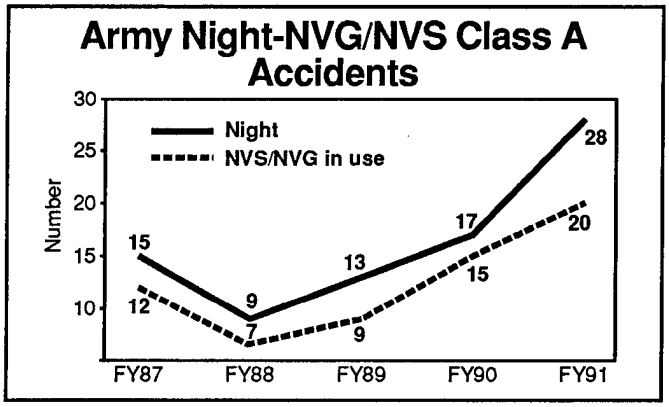


Figure 1-5

The cumulative Class A-C accident rate for FYs 87 through 91 was 3.43 per 100,000 flight hours based on an overall Army total of 8,128,377 hours flown.

Operations Desert Shield/Desert Storm

Army aviation's safety performance steadily improved until the onset of Operations Desert Shield/Desert Storm (DS/S). And Army Safety Center statistical studies suggest that a 5-year downward trend in Class A rotary-wing accidents would have continued had it not been for DS/S. At the 95-percent confidence level, the predicted aviation accident rate was 1.79 per 100,000 flying hours for FY 91 if DS/S had not occurred, down from 1.83 in FY 90. At that rate, the Army would have experienced only 20 Class A accidents in FY 91. However, with DS/S, 49 Class A accidents produced a rate of 3.77 accidents per 100,000 flying hours, more than double the peacetime estimates.

During DS/S, only 17 percent of our flying was at night, but 68 percent of our rotary-wing accidents occurred at night. This produced a rate of 56 accidents per 100,000 night flying hours, which is 11 times higher than the

Table 1-1. Accident classification criteria

Class A accident The resulting total cost of reportable damage is $1 million or more; a DOD aircraft is destroyed; or an injury and/or occupational illness results in a fatality or permanent total disability.
Class B accident The resulting total cost of reportable property damage is $200,000 or more, but less than $1 million; an injury and/or occupational illness results in permanent partial disability; or five or more personnel are hospitalized.
Class C accident The resulting total cost of property damage is $10,000 or more, but less than $200,000; a nonfatal injury that causes any loss of time from work beyond the day or shift on which it occurred; or a nonfatal illness or disability that causes loss of time from work or disability at any time (lost-time case).
Class D accident The resulting total cost of property damage is $2,000 or more but less than $10,000, or a nonfatal injury that does not meet the criteria of a Class C mishap (no-lost-time case).
Class E incident The resulting cost of property damage is less than $2,000. AR 385-40, paragraph 4-6e, defines Class E incidents in detail.
FOD incident Reportable incidents confined to turbine engine damage as a result of internal or external turbine engine foreign-object damage (FOD). FOD incidents are to be reported on a PRAM as an "FOD incident" regardless of cost.

Note: Classification is based solely on property damage or injury/illness severity (fatal, permanent partial disability, etc.), not injury cost.

rate experienced by operational units during peacetime. Although the numbers were higher, accidents during DS/S revealed the same problem areas we have experienced in peacetime for the last 5 years.

Human error

Human error accounted for about 75 percent of the accidents during the 5-year period covered in this report. The most frequent error identified in Class A though C accidents was failure to follow established rules or procedures. The second most prevalent error involved aircrews displaying a lack of attention to the task at hand or misdirecting their attention, thus resulting in an accident. The third most common error involved misjudging clearance, speed, or distance.

Of these human errors, some were attributable to failures on the part of individuals (table 1-2). The individuals knew and were trained to a standard but elected not to follow the standard. These individuals lacked the self-discipline to follow the standard because of a false sense of mission urgency, overconfidence in their own or someone else's abilities, and so forth.

Performing to standards is a requirement that cannot be put aside if we want to avoid accidents, whether we are operating in a peacetime environment or are transitioning to a combat theater. It is ultimately up to unit commanders to enforce standards and ensure that individuals comply with the standards set for each task. However, the individual aviator is the basic component in the equation for the reduction of human errors. And if human errors are not reduced, they will continue to cause accidents in peacetime and they will accelerate accidents in the next war just as they did in DS/S.

Table 1-2. Sources of human error

Source	Readiness Shortcoming
Individual	Soldier knows and is trained to standard but elects not to follow standard (self-discipline).
Leader	Leader does not enforce known standard.
Training	Soldier is not trained to known standard (insufficient, incorrect, or no training on task).
Standards	Standards or procedures are not clear or practical or do not exist.
Support	Equipment or materiel is improperly designed or not provided; or maintenance, facilities, or services are inadequate.

Section II

UH/MH/EH-60 Safety Performance Review

The H-60 was involved in 25 Class A accidents, 12 Class B accidents, and 44 Class C accidents during the FY 87 through FY 91 time period. These accidents resulted in 52 military fatalities and 68 disabling injuries. The H-60 cumulative Class A-C accident rate for the period was 2.89 per 100,000 flying hours based on a total of 864,099 hours, compared to the total rotary wing cumulative Class A-C rate of 3.43.

The leading cause of H-60 accidents continues to be human error. Findings in the 25 Class A accidents were distributed as follows: 25 individual failures, 5 standards failures, 2 training failures, 3 leader failures, 4 environmental causes, and 6 materiel failures. (Keep in mind that each accident may have more than one cause factor.)

Materiel failure accounted for 6 of the 25 Class A accidents: 3 involved a tail-rotor-control malfunction, 1 an engine failure, 1 a cargo-hook failure, and 1 a rappel-rope-attachment failure.

Of the 25 Class A accidents, 18 occurred at night. In all but 2 of the 18, the pilots were using night vision goggles (NVGs).

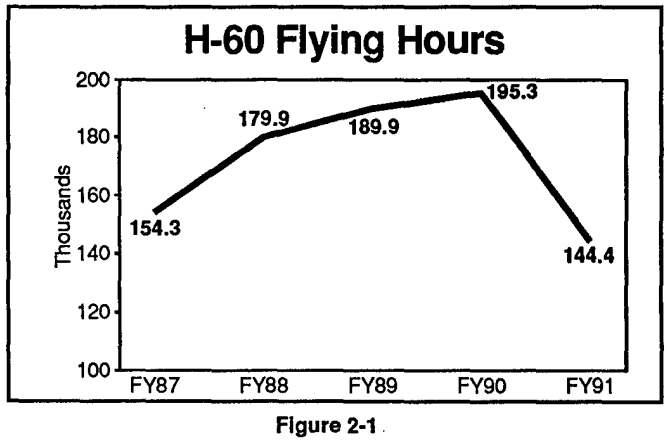
During Operations Desert Shield/Desert Storm, the H-60 accounted for 6 of the 29 Class A accidents (not including combat losses). All six H-60 accidents occurred at night with NVGs in use.

Accident experience

H-60 accident experience reflects the historical profile of all other Army aircraft. With each aircraft, problems have been encountered with system reliability and maintenance during the initial development and fielding cycle. Figures 2-1 through 2-5 depict H-60 trends over the 5-year period. Note that trends may appear skewed in FY 91 due to Operations Desert Shield/Storm.

Figure 2-1 shows a significant increase in H-60 flying hours through FY 90. The reduction in FY 91 resulted from flying hours being pulled from units and given to DS/S deployed units.

Figure 2-2 shows H-60 Class A accidents. Particularly noteworthy is the fact that, until



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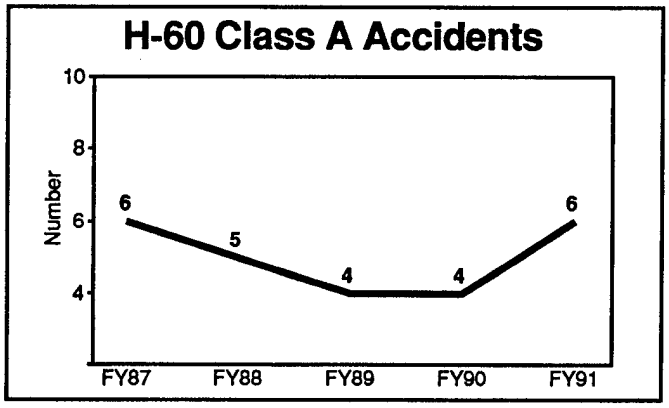

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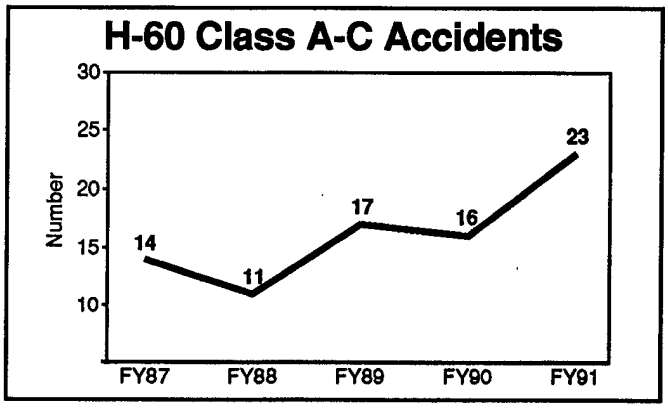

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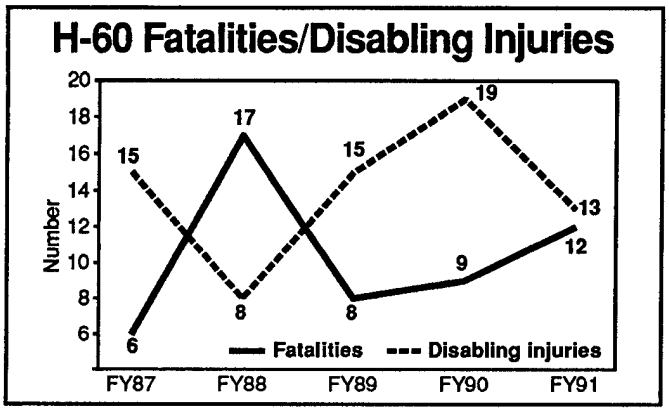

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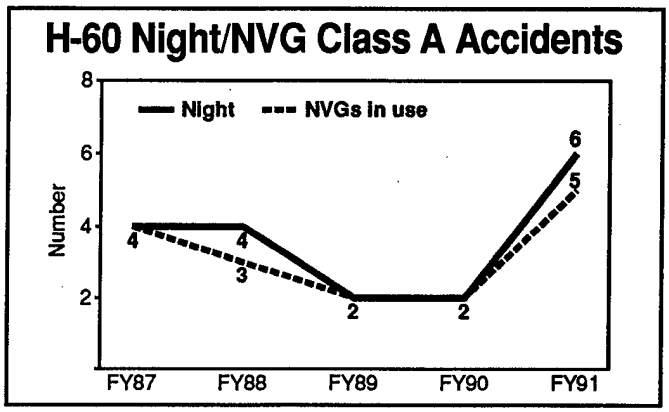


Figure 2-5

DS/S, Class A accidents steadily decreased while flying hours steadily increased.

Figure 2-3 shows the H-60 Class A-C accident trend. FYs 87 through 90 show a slight increase, with FY 91 skewed by DS/S accident experience.

Figure 2-4 shows the fatalities and disabling injuries resulting from H-60 accidents. The dramatic increase in fatalities in fiscal 88 resulted from a midair collision between two H-60s that killed 17 soldiers.

Figure 2-5 shows H-60 Class A accidents that occurred at night and those that occurred with NVGs in use. Note that in all but 2 of the 18, NVGs were in use.

Selected Class A accident briefs

Materiel failure

The aircraft was taking off from a confined area. As the pilot added power, the number 1 power turbine wheel in the number 1 engine failed. Due to low airspeed and high gross weight, number 2 engine power available was insufficient to maintain flight. The aircraft settled into the trees.

Result: **Thirteen disabling injuries, a destroyed aircraft, and a cost of $7,216,000.**

Cause: The engine failed due to debonding and loss of portions of the shroud segment honeycomb and filler material in the turbine case. This created an uneven surface on the stator honeycomb, which disrupted airflow around the gas generator rotor blade tips. This created a resonance frequency and stress, which caused cracking in the blade root and subsequent fracturing of the blades. Contributing to the severity of the injuries was the fact that troop seats and restraint systems had been removed from the aircraft.

Cause: **Failure of number 1 turbine at an altitude, airspeed, and gross weight where single-engine power was insufficient to maintain flight.**

Crew experience: The PC had 2,712 rotary-wing hours, 1,896 in UH-60s. The P had 2,347 rotary-wing hours, 1,206 in UH-60s.

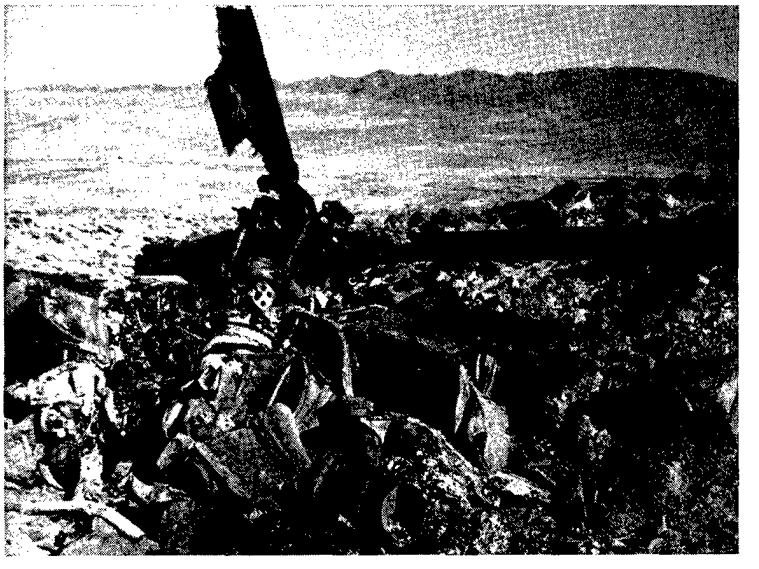
Recommended actions: *Higher level:* **Inform all assigned of this accident and provide restraint systems and seats for all occupants.** *Army level:* **Accelerate the application of MWO 55-2840-248-5032 for all T700-GE-700 engines, which will add a damper to the turbine blades. Develop an engine-vibration inspection to identify engines with excessive resonance-frequency vibrations.**

Failure to maintain terrain clearance

The aircraft departed a field location en route to an assembly area to deliver gun targets. The crew reported their first checkpoint and soon thereafter made a position report to their unit operations. Then, at approximately 120 knots airspeed, the aircraft struck a ridge 8 feet below the crest.

Result: **Four fatalities, a destroyed aircraft, and a cost of $8,048,397.**

Cause: The crew failed to maintain terrain clearance. The most probable reason for this failure is that either the crew was overconfident in their ability to fly low and fast without striking obstacles, or the crew's attention was drawn to something inside the cockpit. Because of the high airspeed at low altitude, the crew had less reaction time to avoid obstacles.



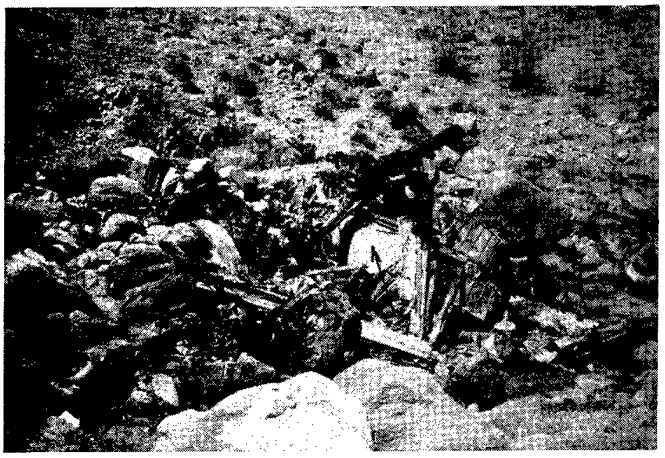
Cause: **Failure to maintain terrain clearance while flying low and fast.**

Crew experience: The PC had 1,160 rotary-wing hours, 980 in UH-60s. The PI had 360 rotary-wing hours, 144 in UH-60s.

Recommended actions: **Discuss tactical flight procedures for desert and mountainous terrain, as written in TC 1-201, with emphasis on terrain flight techniques, aircrew responsibilities, navigation, and aircraft performance and handling.**

Poor cockpit coordination

During night terrain flight at 70 knots and 20 feet agl, the master caution light and an undetermined segment light came on. The IP took the controls and subsequently struck a large boulder. The aircraft cartwheeled and came to rest in an upright position.



Cause: **Poor cockpit coordination and excessive command pressure.**

Result: **Six fatalities, one disabling injury, a destroyed aircraft, and a cost of $6,536,740.**

Cause: This accident resulted from a combination of factors, one of which was lack of cockpit teamwork. The attention of the IP and the PI, both of whom were using NVGs, was probably drawn inside the cockpit when the master caution light illuminated. But just as causal was the command climate of excessive pressure within the unit. The unit's aircrew training program was not being conducted in accordance with AR 95-1. The NVG mission was being flown by an IP who was not current in NVG flight and a pilot who was not unit mission qualified.

Crew experience: The IP had 5,386 rotary-wing hours, 1,546 in the UH-60. The PI had 2,024 rotary-wing hours, 326 in the UH-60.

Recommended actions: *Higher level:* **Inform subordinate commands of the facts surrounding this accident, with emphasis on cockpit coordination during NVG operations.** *Army level:* **DA advise all commands of the importance of understanding aviation unit capabilities and limitations to preclude overcommitment of aviation resources.**

Inadequate procedures

A flight of three UH-60s was on an inbound corridor to land when the lead aircraft collided with a single UH-60 also entering the corridor for landing. The crew of both accident aircraft were using NVGs. No evasive actions were taken prior to impact.

Result: **Seventeen fatalities, two destroyed aircraft, and a cost of $11,570,060.**

Cause: The lead UH-60 was flight following with unit operations, while the single UH-60 was flight following with the post facility. There was no require-

ment for the aircrews to make position reports on a common frequency, which would have alerted both accident UH-60s of their merging course. Contributing to this accident were the visual limitations associated with NVGs and the restricted field of view of UH-60 front and side windows.

Crew experience: The IP in the lead UH-60 had 2,778 rotary-wing hours, 2,184 in UH-60s, and the PI had 295 rotary-wing hours, 118 in UH-60s. The IP in the single UH-60 had 2,084 rotary-wing hours, 657 in UH-60s, and the PI had 872 rotary-wing hours, 36 in UH-60s.

Cause: **Aircrews failed to see and avoid each other due to equipment design and flight-following procedures.**

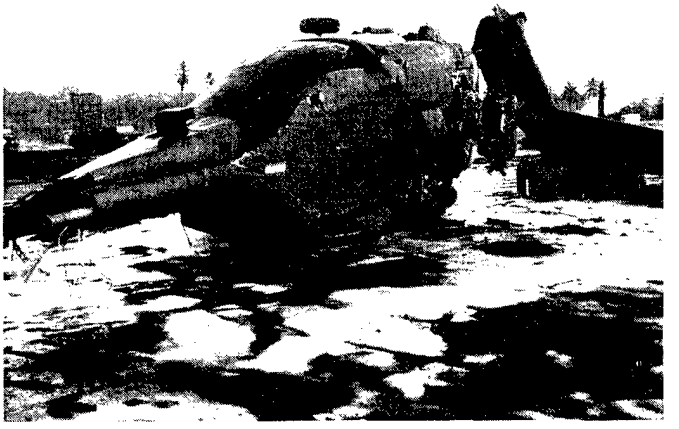
Recommended actions: *Higher level:* **Establish flight-following procedures on a common frequency that requires position reporting.** *Army level:* **Improve the field of view of UH-60 pilot/copilot windscreen, side windows, and gunner's door windows.**

Training failure

When aircraft #1 picked up to a hover on an uncontrolled airfield, it began sliding left onto the runway. Its rotor blades came into contact with another UH-60 that was hovering down the runway, and both aircraft rolled over. The crews of both UH-60s were using NVGs.

Result: **Eight injuries, two destroyed aircraft, and a cost of $9,202,065.**

Cause: The crews of the two aircraft failed to see each other in time to avoid the collision. The IP of aircraft #1 was not adequately trained to perform the duties of NVG IP. As a result, he became task saturated and forgot to call out of parking and taking the runway. His lack of radio calls precluded the crew of the UH-60 hovering down the runway from knowing that there was any traffic on the runway.



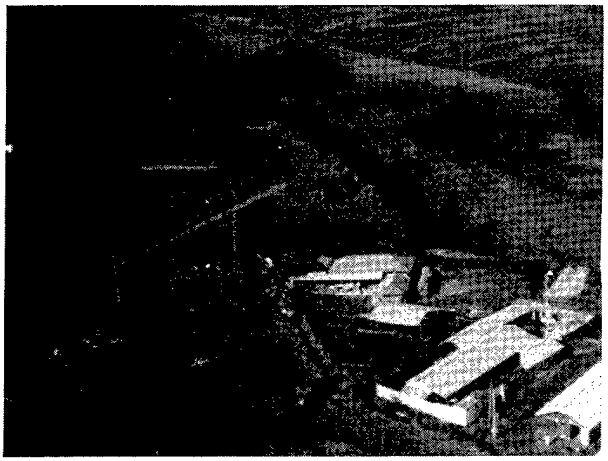
Cause: **Pilot failed to alert other aircraft of his intentions.**

Crew experience: Aircraft #1 IP had 1,769 rotary-wing hours, 1,598 in UH-60s; PI had 459 rotary-wing hours, 286 in UH-60s. Aircraft #2 IP had 3,660 rotary-wing hours, 2,663 in UH-60s; PI had 660 rotary-wing hours, 485 in UH-60s.

Recommended actions: **Ensure that NVG IPs receive proper unit training in accordance with FM 1-219 and that crew chiefs/observers are adequately trained in clearing their aircraft of hazards.**

Standards failure

At termination of an NVG proficiency evaluation and qualification training mission, two UH-60s joined up as a flight to return to the airfield. While attempting a passing maneuver, the two aircraft meshed main rotor blades. One UH-60 autorotated under control but crashed; the other fell out of control.



Cause: **Pilot drifted into another aircraft during formation lead change.**

Results: **Three fatalities, three disabling injuries, two destroyed aircraft, and a cost of $10,092,245.**

Cause: While attempting to exchange the lead by passing on the right side, the crew of the passing UH-60 allowed the aircraft to drift into the UH-60 being passed. This occurred in part because of inadequate written procedures for NVG multiship operations addressing lead changes, minimum crew requirements, separation distances, appropriate NVG formations, and which crewmembers should be goggled up.

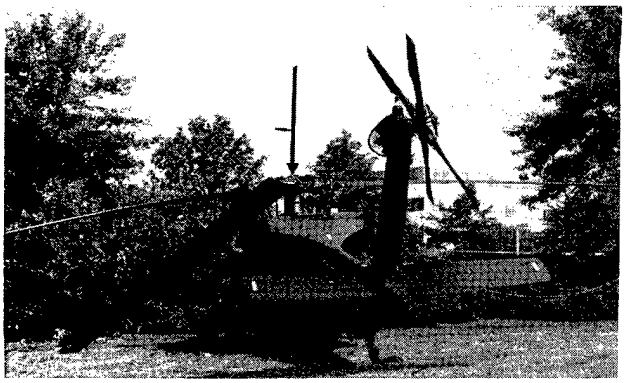
Crew experience: In the passing UH-60, the IP had 5,269 rotary-wing hours, 678 in the UH-60, and the PI had 278 rotary-wing hours, 71 in UH-60s. In the UH-60 being passed, the IP had 2,242 rotary-wing hours, 2,026 in UH-60s, and the PI had 476 rotary-wing hours, 300 in UH-60s.

Recommended actions: *Army level:* **Form a study group to clarify NVG doctrine; tactics, training, and qualification requirements; and equipment and personnel requirements based on known limitations of the AN/PVS-5 NVG and UH-60. Restrict inflight lead changes and formation changes during NVG multiship operations until adequate procedures have been developed.**

Selected Class B accident briefs

Pilot error

During approach to perform a fast-rope rappelling demonstration, stabilator caution light and audio came on. The UH-60 landed hard, bounced forward, and struck a tree with the main rotor system.



Cause: **Pilot chose wrong course of action for a stabilator malfunction.**

Result: **$231,904 in damage.**

Cause: IP chose the wrong course of action for a stabilator malfunction (automatic mode failure). Instead of making a go-around or bringing the aircraft to a hover, he attempted a forced landing with insufficient forward clearance from trees. His judgment was affected by several factors: distraction, lack of confidence in aircraft performance, and lack of knowledge of stabilator manual mode operations.

Crew experience: The IP had 2,697 rotary-wing hours, 2,402 in UH-60s. The PI had 295 rotary-wing hours, 126 in UH-60s.

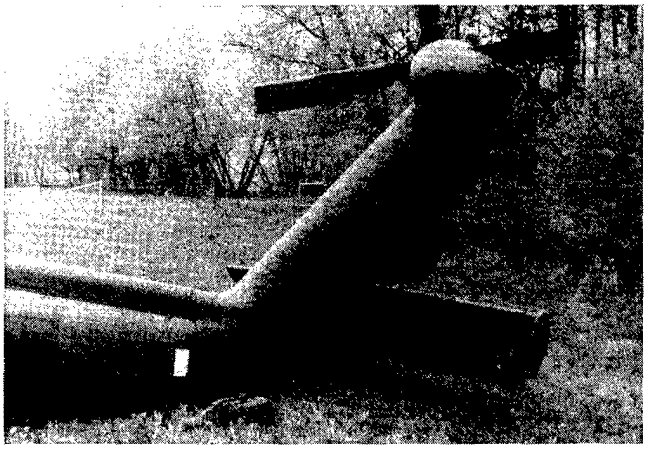
Recommended actions: **Provide additional instruction to the IP on the capabilities of the UH-60 with the stabilator in a fixed position.**

Tail rotor drive shaft failure

During an 80-knot climb to 3,000 feet, the tail rotor malfunctioned. The PC increased airspeed in an attempt to streamline the aircraft, but then had to execute an autorotation to an unimproved location. The aircraft landed with a high rate of descent and a right yaw.

Result: **$267,980 in damage.**

Cause: The transmission blower shaft retaining nut was improperly torqued by the manufacturer. This allowed the shaft to develop play, which eventually caused the flange splines to fail.



Cause: **Failure of the transmission blower shaft splines.**

Crew experience: The PC had 1,391 rotary-wing hours, 370 in UH-60s. The PI had 490 rotary-wing hours, 224 in UH-60s.

Recommended actions: *Army level:* **Issue AVUM units a flex boroscope so that a complete inspection of the drive shaft can be made.**

Wire strike

While on approach to land at the scene of a UH-60 wire strike, a second UH-60 struck a steel guide wire atop a 30-meter-tall electrical power support tower (same set of wires that the first aircraft hit). The wire rode up the windscreen and tore off the pylon access cover before snapping in two. The wire then whipped into one of the rotor blades.

Result: **$431,161 in damage.**

Cause: The IP failed to plan his approach to avoid the wires, which he had marked on his hazard map and knew were in the area.

Cause: **Pilot failed to avoid wires that he knew were in the area.**

Recommended actions: **Publicize the need for pre-mission planning, including responding to emergencies or missions flown in response to short-notice or urgent requests.**

Selected Class C accident briefs

Lack of crew coordination

The UH-60 was chalk four in a flight of four flying staggered right formation and using NVGs. About 20 feet above the ground, the copilot, who was on the controls, lost visual reference in blowing dust. The PC still had contact with the ground and did not know that the PI had lost visibility. As the aircraft touched down, the PC also lost visual reference. The aircraft developed a left roll and all four rotor blades struck the ground. The PC took the controls and applied the correct input to keep the aircraft from continuing to roll.

Result: **$104,034 in damage.**

Cause: The PI, who was on the controls, failed to alert the PC that he had lost visual reference with the ground. The PC, who could still see the ground, was not afforded the opportunity to continue the approach.

Crew experience: The PC had 3,400 rotary-wing hours, 340 in UH-60s. The PI had 7,200 rotary-wing hours, 132 in UH-60s.

Recommended actions: **Review SOPs concerning NVG operations and publicize circumstances of this accident.**

Maintenance error

While at a hover on a maintenance test flight, the pilot increased collective to depart, and an uncommanded left spin developed. The UH-60 completed 11 turns before the pilot was able to land.

Result: **$31,615 damage from hard landing.**

Cause: Mechanic saw a teflon washer that needed replacing on the tail rotor forward quadrant. He disconnected the tail rotor control rod and replaced the washer, but then failed to reconnect the rod end. He also failed to write up the work he performed.

Recommended actions: **Change operating procedures to require documentation of all maintenance performed on aircraft and components.**

Poor crew coordination

Crew was performing NVG slingload operations when the copilot, who was on the controls, began having trouble maintaining position over the load (M102 howitzer) due to low illumination and blowing dust. The PC attempted unsuccessfully to release the load using the primary release button. The PI misunderstood that the load had been released, and began to slide to the left and descend to land. The aircraft drifted back to the right and descended on the load.

Result: **$51,471 damage to the howitzer and $3,840 damage to the UH-60.**

Cause: The PI misinterpreted the crew chief's commands. Believing that the load had been released, the PI repositioned the aircraft to the left and down, subsequently landing on the slingload.

Crew experience: The PC had 638 rotary-wing hours, 462 in UH-60s. The PI had 886 rotary-wing hours, 716 in UH-60s.

Recommended actions: *Army level:* **Develop an exportable aircrew coordination training package.**

Section III

OH-58D Safety Performance Review

The OH-58D was involved in 10 Class A accidents, 5 Class B accidents, and 10 Class C accidents during the FY 87 through FY 91 time period. These accidents resulted in 2 fatalities and 7 disabling injuries. The OH-58D cumulative Class A-C accident rate for the period was 9.13 per 100,000 flying hours based on a total of 96,117 hours, compared to the total rotary wing cumulative Class A-C rate of 3.43.

The leading cause of OH-58D accidents continues to be human error. Findings in the 10 Class A accidents were distributed as follows: 9 individual failures, 2 standards failures, 1 training failure, and 2 materiel failures. (Keep in mind that each accident may have more than one cause factor.)

Materiel failure accounted for 2 of the 10 Class A accidents. One was an engine flame-out due to air ingestion 5 minutes after the fuel boost pump failed. The other was an abrupt loss of engine power due to an unknown reason.

Of the 10 Class A accidents, 8 occurred at night. In all of the night accidents, the pilots were using NVGs.

During Operations Desert Shield/Desert Storm, the OH-58D accounted for 3 of the 29 Class A accidents.

Accident experience

OH-58D accident experience reflects the historical profile of all other Army aircraft. With each aircraft, problems have been encountered with system reliability and maintenance during the initial development and fielding cycle. Figures 3-1 through 3-5 depict OH-58D trends over the 5-year period.

Figure 3-1 shows a significant increase in OH-58D flying hours through FY 90. The reduction in FY 91 resulted from flying hours being pulled from units and given to DS/S deployed units.

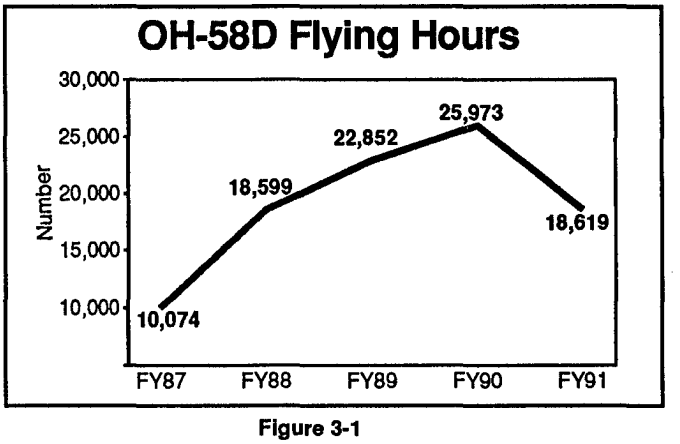


Figure 3-1

Figure 3-2 shows OH-58D Class A accidents.

Figure 3-3 shows the OH-58D Class A-C accident trend. FYs 88 through 90 show a significant increase, with FYs 90 and 91 high due to DS/S.

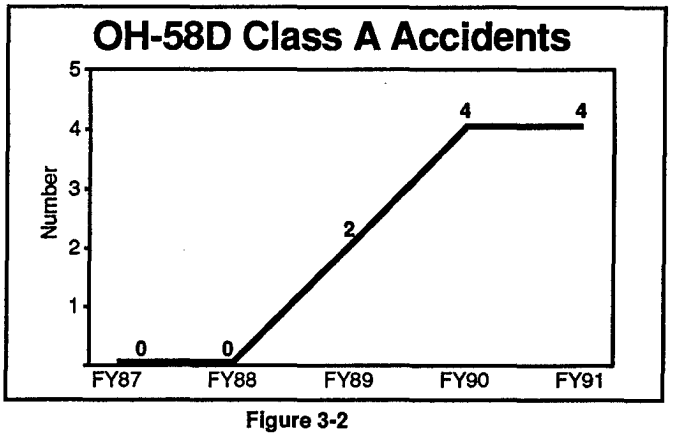


Figure 3-2

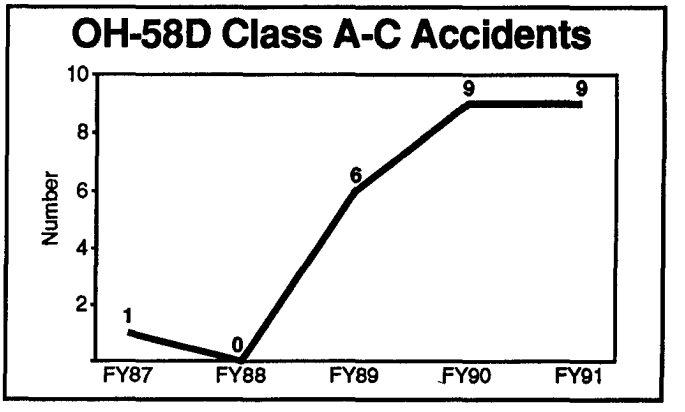


Figure 3-3

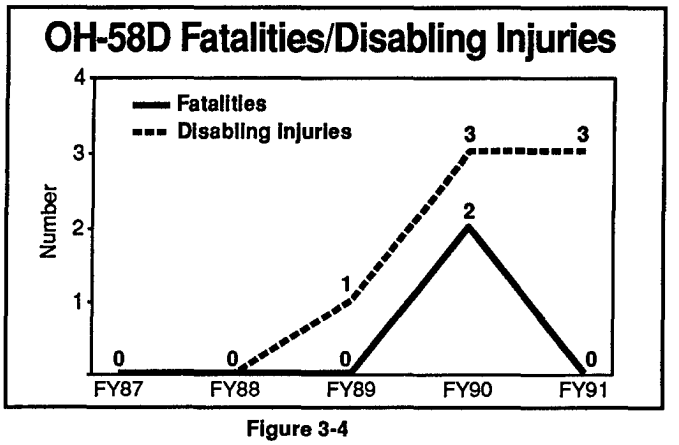


Figure 3-4

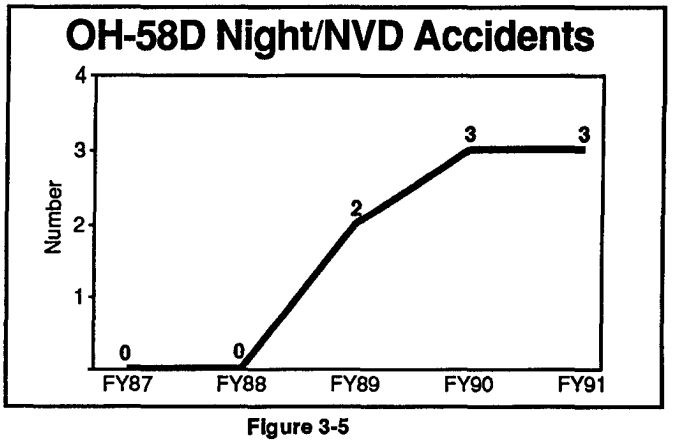


Figure 3-5

Figure 3-4 shows fatalities and disabling injuries resulting from OH-58D accidents.

Figure 3-5 shows OH-58D Class A accidents that occurred at night. In all cases, crews were using NVDs.

Selected Class A accident briefs

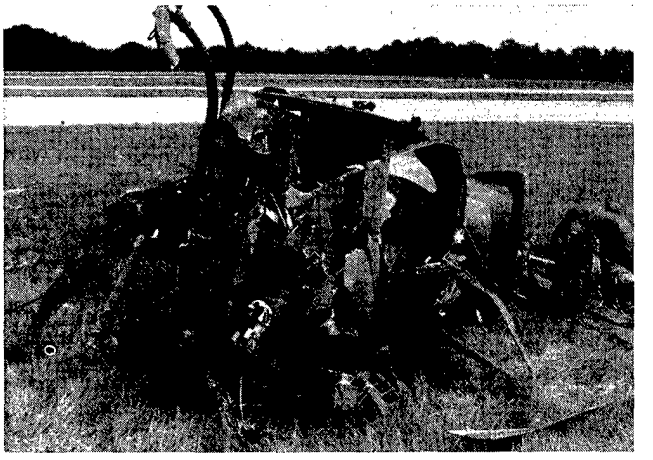
Spatial disorientation

On an NVG training mission while at a forward hover on a stagefield, the IP misinterpreted aircraft attitude. He sensed the aircraft in a pitch-up, right-roll attitude and responded with rapid left forward cyclic and increased collective. This caused the main rotor to tilt down approximately 39 degrees to the left front quadrant (10 to 11 o'clock position) and strike the taxiway. The aircraft then began a rapid right spin, crashing out of control and coming to rest on its left side. The aircraft was damaged beyond economical repair. The rated student pilot's injury required only first aid; the IP received a minor knee injury that placed him in a limited-duty status for 7 days.

Result: **Damage cost of $3,756,840.**

Cause: The IP's actions resulted from a combination of factors that culminated in spatial disorientation. He was self-medicating an aggravated vestibular condition that made him susceptible to spatial disorientation. Although current, the IP was only marginally proficient with NVGs. He had flown with NVGs only 4.9 hours in the previous 4 months.

Crew experience: The IP had 2,687 rotary-wing hours, 171 in OH-58Ds. The RSP had 179 rotary-wing hours, 18 in OH-58Ds.



Cause: **Spatial disorientation.**

Recommended actions: Unit level: **Brief the accident and ensure all personnel are aware of the self-medication restriction in AR 40-8, with specific emphasis on the requirement to notify a flight surgeon before using over-the-counter drugs.** ***Army level:*** **Initiate a study of Army aviators with increased risk for spatial disorientation and the associated flight risks that result from an aggravated vestibular condition.**

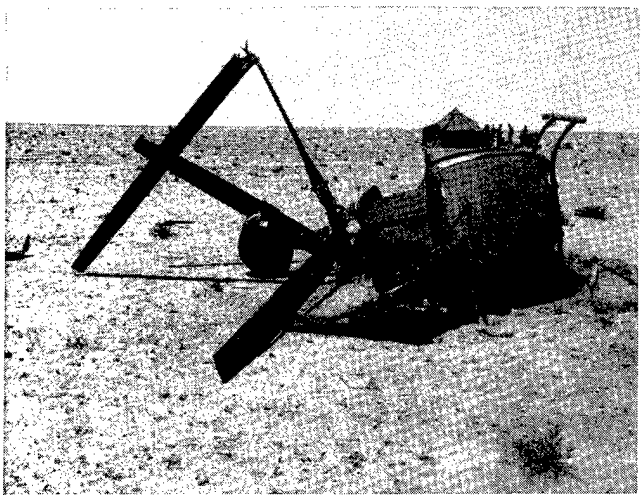
Engine failure

The fuel boost pump had failed over desert terrain, and the pilot was trying to reach a secure area. Five minutes later, during acceleration from 70 to 100 knots at 400 feet agl, the engine failed. The pilot confirmed engine out and entered autorotation, touching down into the wind with about 25 knots groundspeed. The landing gear dug into loose, soft sand, allowing the nose-mounted wire strike protection system cutter to dig into the ground. The aircraft nosed forward, and the main rotor blades struck the ground and then severed the tail boom. The aircraft came to rest on its left side. Both pilots escaped without injury; aircraft damage exceeded economical repair limits.

Result: **Damage cost of $3,756,000.**

Cause: The engine flamed out due to air ingestion after the fuel boost pump failed. Sand caused circumferential wear to the faces of the impeller assembly and plain seal, resulting in loss of pressure. But the resulting engine failure was not the cause of the aircraft being destroyed. The pilot entered autorotation and touched down as he had been taught. However, the operator's manual (-10) and the aircrew training manual do not address autorotative landings with minimum ground run for landing to soft terrain. Additionally, the U.S. Army Aviation School does not provide hands-on instruction in minimum ground run autorotations or permit transition pilots to acquire experience in making minimum ground run autorotative landings.

Crew experience: The PC had 1,814 rotary-wing hours, 411 in OH-58Ds.



Cause: Engine failure followed by emergency landing in soft sand.

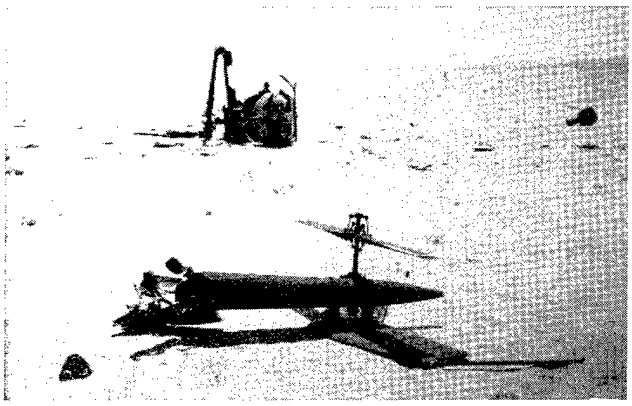
Recommended actions: Unit level: **Emphasize that pilots should anticipate soft terrain when landing to unimproved areas.** ***Army level:*** **Consider changing the material of the impeller and plain seal of the fuel boost pump. Consider incorporating into the OH-58D transition program provisions for giving pilots some level of experience in minimum ground run landing. Evaluate current emergency procedures for in-flight failures of the fuel boost pump; consider whether "land as soon as practical" should be changed to "land as soon as possible." Consider relocating the lower nose-mounted wire cutter to allow more ground clearance.**

Failure to recognize rising terrain

During night tactical training over desert terrain, with ANVIS-6 NVGs in use, the aircraft struck the ground. The PC took the controls and initiated a climb in preparation for executing a precautionary landing. After about 15 to 20 seconds, the aircraft struck rising terrain, slid to a stop, and rolled onto its right side. Neither crewmember was injured.

Result: **Damage cost of $3,756,000.**

Cause: The crew failed to recognize rising desert terrain in their flight path due to (1) inadequate unit training in flying under night, aided, totally blacked out conditions; (2) haste to catch up with their sister element, resulting in their overflying the capability of their NVGs to provide adequate terrain definition under the totally blacked out desert conditions; (3) substandard NVGs, which placed the crew at a disadvantage in an already difficult situation; and (4) lack of a radar altimeter audio signal that would have warned the crew they were approaching critical proximity to the ground.



Cause: Failure to recognize rising terrain.

Crew experience: The PC had 3,996 rotary-wing hours, 952 in OH-58Ds. The PI had 924 rotary-wing hours, 51 in the OH-58D.

Recommended actions: Unit level: **Emphasize the hazards associated with lack of visual cues in the desert. Ensure that maintenance and inspections are being performed on night vision devices in accordance with established directives.** ***Army level:*** **Establish a theater-level standardization office to ensure existing tasks/conditions/standards continue to be viable for the theater of operations. Take immediate steps to install software that will provide OH-58D pilots with a radar altimeter audio signal.**

Overconfidence/inadequate procedures

During a night aided approach and landing to the flight deck of a moving ship, the pilot misjudged his position and overlapped his rotor system with that of an operating aircraft already on the deck. Neither crew was injured.

Result: **Damage cost of $2,455,746.**

Cause: The pilot erred due to (1) overconfidence in his own ability to perform this difficult maneuver without adequate assistance from his copilot and (2) unit failure to provide written procedures that would have allowed the maneuver to be performed with an adequate margin for error.

Crew experience: The PC had 2,023 rotary-wing hours, 168 in OH-58Ds. The PI had 659 rotary-wing hours, 103 in OH-58Ds.

Cause: **Overconfidence and inadequate procedures.**

Recommended actions: Unit level: **Inform all personnel of the circumstances of this accident, with emphasis on how overconfidence contributed.** ***Higher level:*** **Establish procedures for making decisions to allow simultaneous dual-aircraft operations from ships whose flight decks have been designated as single-spot decks.**

Engine failure

During a night mission at 30 feet above the water at 80 knots, with the crew using ANVIS-6(V)-1 NVGs, an abrupt loss of power occurred, accompanied by both aural and instrument engine-out indicators. The PC applied aft cyclic to reduce airspeed prior to impact with the water. The aircraft hit the water in a nose-high attitude at about 50 knots indicated airspeed and sank. Both crewmembers exited the aircraft under water, surfaced, and were picked up by another aircraft. The PC sustained a lacerated knee and re-injured his back during the crash sequence. The aircraft sank in 92 feet of water and remained there for 30 days.

Result: **Damage cost of $6,127,655.**

Cause: Due to extensive saltwater damage to the engine, the cause of the power failure/malfunction could not be determined.

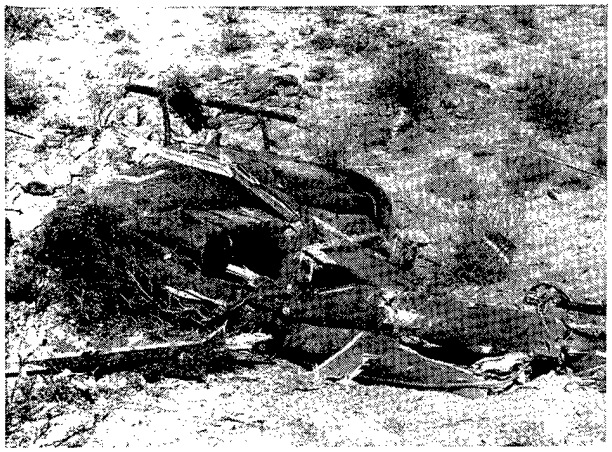
Crew experience: The PC had 6,307 rotary-wing hours, 369 in OH-58Ds. The PI had 526 rotary-wing hours, 369 in OH-58Ds.

Recommended actions: Unit level: **Brief assigned personnel on the importance of survival training and the need for rigorous, by-the-book maintenance.** ***Army level:*** **Publish the circumstances of this accident in *Flightfax*, emphasizing the fact that the crew survived only because of extensive survival training and the use of specialized survival equipment acquired with unit funds.**

Selected Class B accident briefs

Failure to follow procedures

During night tactical training with ANVIS-6 NVGs in use, the low-fuel caution light illuminated. The aircraft was flown another 6 minutes and landed at a lager site, where it was shut down about 10 minutes later. The aircraft was later started and departed the lager site with the low-fuel caution light illuminated and 52 to 58 pounds of fuel on board. About 1 minute into the flight, during a slow right turn at 50 knots and 100 to 200 feet agl, the engine quit. The aircraft was autorotated and landed in a rocky area. The left skid settled atop a large rock, and the aircraft rolled to the right, destroying the rotor system and causing major damage to the aircraft. There were no injuries.



Cause: **Failure to follow procedures.**

Result: **Damage cost of $689,600.**

Cause: The PC did not comply with the operator's manual for illumination of the low-fuel caution light and did not comply with VFR fuel-reserve requirements outlined in AR 95-1. He was overconfident that he could fly 7 kilometers with the fuel remaining because he had previously flown with the low-fuel caution light illuminated and a low fuel quantity indicated on the fuel gauge.

Crew experience: The PC had 637 rotary-wing hours, 245 in the OH-58D.

Recommended actions: Unit level: **Inform all assigned aviators of the facts and circumstances surrounding this accident, with emphasis on landing as soon as practical when the low-fuel caution light illuminates. Ensure that the standardization program is teaching procedures for the low-fuel caution light and reinforcing fuel-reserve requirements.** ***Army level:*** **Publish a change to the operator's manual warning pilots of the possibility of fuel starvation while flying after the low-fuel caution light illuminates.**

Materiel failure

While in cruise flight on a routine training mission, the IP initiated a simulated engine failure. At 400 feet agl, he attempted to make a power recovery. However, the aircraft lost power and began losing rpm, resulting in a near-vertical descent. When the aircraft hit the ground, the tail boom was severed from the fuselage, and extensive damage was sustained to the main rotor blades and landing gear. The IP sustained a minor injury from being struck by a slow-turning collapsed main rotor blade.

Result: **Damage cost of $320,959.**

Cause: Engine failure resulted from a loose compressor discharge

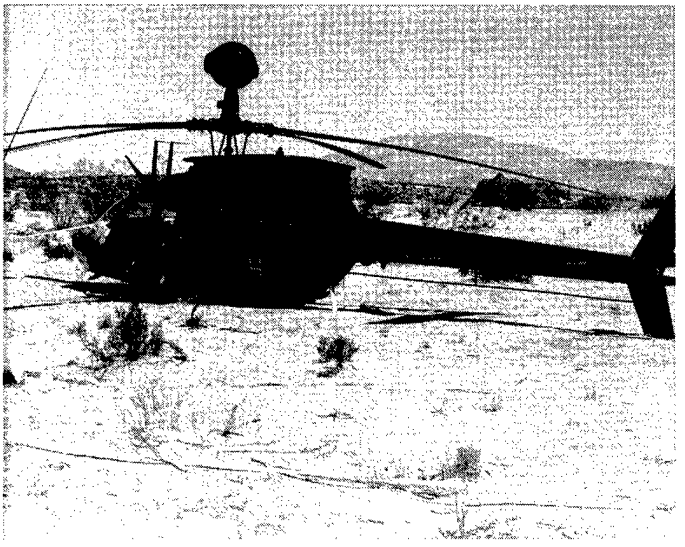
pneumatic (PC) air line. The loss of PC air intensified the fuel control's inability to properly meter fuel flow when engine speed was manually reduced, resulting in an engine flame-out. The PC air line had vibrated loose enough to cause the engine to flame out during the simulated forced-landing maneuver, and the IP failed to recognize the engine-out condition prior to initiating his power recovery. He further erred by applying collective pitch in anticipation of rotor overspeed, allowing rotor rpm to decay below acceptable limits.

Crew experience: The IP had 3,124 rotary-wing hours, 215 in OH-58Ds. The observer had 157 rotary-wing hours, 120 in the OH-58D.

Recommended actions: Unit level: **Ensure all OH-58D aircraft are inspected for proper installation of engine compressor discharge air lines and that all PC air lines be checked for leaks prior to the next flight. Inform assigned personnel of how inadequate attention to detail contributed to this accident.** ***Army level:*** **Take action to improve the design of PC air discharge fittings to incorporate a switching valve to allow PC air blockage rather than removing lines and capping fittings as presently required.**

Materiel malfunction

During a night approach at approximately 65 feet and 35 to 40 knots, with the crew using ANVIS-6 NVGs, a "whoosh" sound was followed by total power loss. The pilot entered autorotation, zeroed out the airspeed to avoid a group of large rocks in his flightpath, leveled the aircraft, and applied collective at about 10 feet to slow the rate of descent. The aircraft landed hard in a level attitude on level ground, and the crew exited unassisted.



Cause: **Loose "B" nut that connects fuel hose to fuel boost pump.**

Result: **Damage cost of $243,744.**

Cause: The engine failure was caused by a loose "B" nut that connects the fuel hose to the fuel boost pump. The loose nut allowed major air induction into the fuel supplied to the engine.

Crew experience: The PC had 1,139 rotary-wing hours, 225 in OH-58Ds. The AO had 125 rotary-wing hours, 82 in the OH-58D.

Recommended action: Army level: **Issue a safety-of-flight message to the field requiring a one-time inspection of all fuel system "B" nuts attaching fuel hoses to the fuel boost pumps in the OH-58D.**

Selected Class C accident briefs

Failure to follow procedures

The crew was performing a simulated engine failure from altitude. When the IP announced "simulated engine failure," the PI rolled the throttle to the engine idle stop. All instrument indications were normal. At 75 to 80 feet, the PI began to decelerate. The IP felt the aircraft falling through the decel and placed his hand on the collective. He realized that the throttle was not full open. The PI was starting to pull in some collective to terminate at a hover. The IP tried to open the throttle and both pilots tried to cushion the impact with the collective. The aircraft hit hard and fairly level with 15 to 20 degrees of right yaw and slid 20 to 30 feet, damaging the skids, tail rotor drive shaft cover, lower wire cutter, and belly of the aircraft.

Result: Damage cost of $19,132.

Cause: The PI failed to return the throttle to the full open position, which would have restored normal engine rpm. The IP failed to announce "termination with power" and failed to check that the pilot had reestablished normal engine rpm before passing through 100 feet agl.

Crew experience: The IP had 2,700 rotary-wing hours, 2,342 in the OH-58D. The PI had 216 rotary-wing hours, 39 in the OH-58D.

Recommended action: **Emphasize to instructor pilots that they must enforce standards outlined in the aircrew training manual.**

Hard landing

During mast mounted sight (MMS) operations at a 3- to 5-foot hover, at night, using ANVIS-6 NVGs, the pilot released the collective with his left hand and reached to input new codes into the transponder. In doing so, he bumped the collective, causing the collective to go down. The aircraft lost altitude and hit the ground in a level attitude.

Result: **Damage cost of $89,952.**

Cause: Normally the aerial observer (AO) changes the codes in the transponder using his display and keyboard while the pilot continues to fly the aircraft. In this case, the AO was tracking a target with the MMS and the pilot didn't want to disrupt him. So the pilot elected to input the new codes himself. The 3- to 5-foot hover altitude did not allow time for corrective actions prior to contact with the ground.

Crew experience: The pilot had 657 rotary-wing hours, 83 in the OH-58D. The AO had 181 rotary-wing hours, 130 in OH-58Ds.

Recommended action: **Ensure all personnel are briefed on crew coordination/duties and how the lack thereof contributed to this accident.**

Tree strike

During night tactical training, with ANVIS-6 NVGs in use, the aircraft landed in a large field bordered by trees. After hovering for 15 to 20 minutes while practicing calls for fire and spot reports, the aircraft drifted 40 feet to the rear. The pilot felt an unusual vibration and immediately landed the aircraft. The tail rotor had struck a small pine tree and caused extensive damage to both tail rotor blades.

Result: **Damage cost of $28,732.**

Cause: It had been 42 days since the PC had flown with NVGs and 37 days for the PI. The PC and PI both became preoccupied inside the aircraft with the radio calls and failed to maintain an adequate visual scan outside the aircraft, allowing the aircraft to drift aft into the tree.

Crew experience: The PC had 685 rotary-wing hours, 136 in the OH-58D. The PI had 342 rotary-wing hours, 182 in OH-58Ds.

Recommended action: **Ensure pilots are scheduled on a frequent-enough basis to build NVG proficiency and not just maintain currency.**

Section IV

AH-64 Safety Performance Review

The AH-64 was involved in 18 Class A accidents, 10 Class B accidents, and 29 Class C accidents during the FY 87 through FY 91 time period. These accidents resulted in 6 military fatalities and 13 disabling injuries. The AH-64 cumulative Class A-C accident rate for the period was 5.99 per 100,000 flying hours based on a total of 320,818 hours, compared to the total rotary wing cumulative Class A-C rate of 3.43.

The leading cause of AH-64 accidents continues to be human error. Findings in the 18 Class A accidents were distributed as follows: 11 individual failures, 2 standards failures, 2 training failures, and 7 materiel failures. (Keep in mind that each accident may have more than one cause factor.)

Of the 7 materiel failures, 5 involved an engine-related malfunction, 1 involved a tail rotor, and 1 involved an auxiliary power unit.

Of the 18 Class A accidents, 8 occurred at night. In all cases, the pilots were using night vision systems (NVS).

During Operations Desert Shield/Desert Storm, the AH-64 accounted for 4 of the 29 Class A accidents (not including combat losses). Two of the AH-64 accidents occurred at night with NVS in use.

Accident experience

AH-64 accident experience reflects the historical profile of all other Army aircraft. With each aircraft, problems have been encountered with system reliability and maintenance during the initial development and fielding cycle. Figures 4-1 through 4-5 depict AH-64 trends over the 5-year period. Note that trends may appear skewed in FY 91 due to Operations Desert Shield/Storm.

Figure 4-1 shows a significant increase in AH-64 flying hours through FY 90. The reduction in FY 91 resulted from flying hours being pulled from units and given to DS/S deployed units.

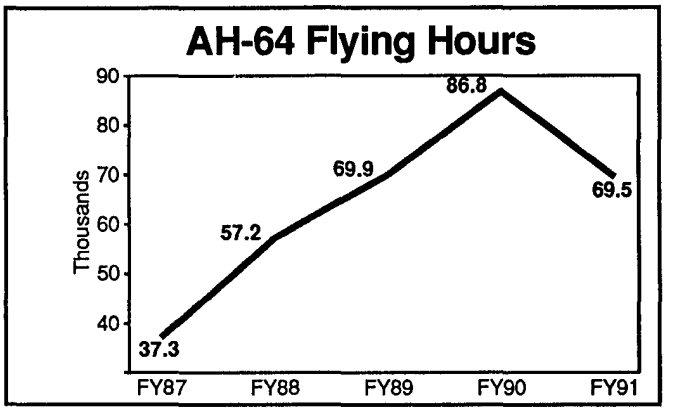


Figure 4-1

Figure 4-2 shows AH-64 Class A accidents. Particularly noteworthy is the fact that, until DS/S,

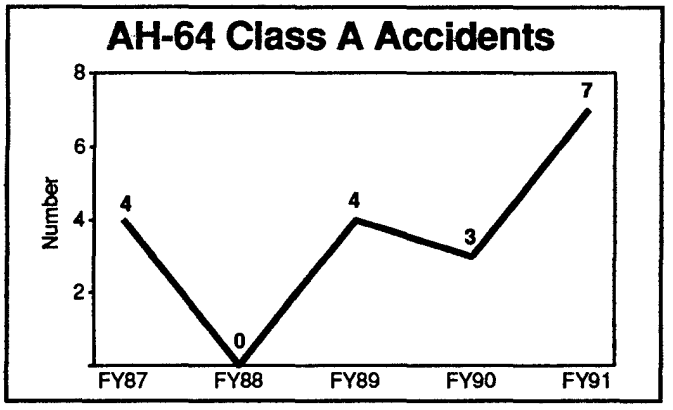


Figure 4-2

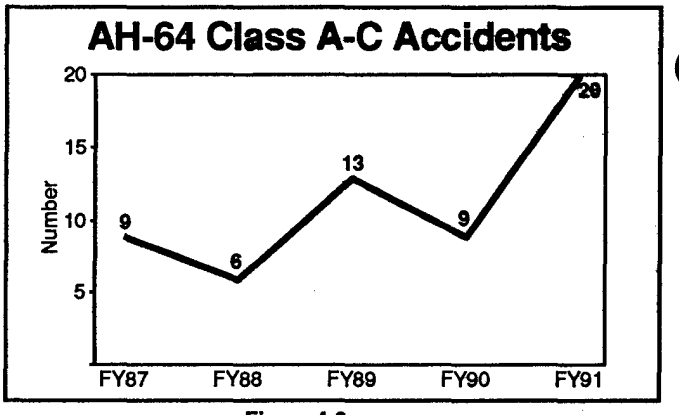


Figure 4-3

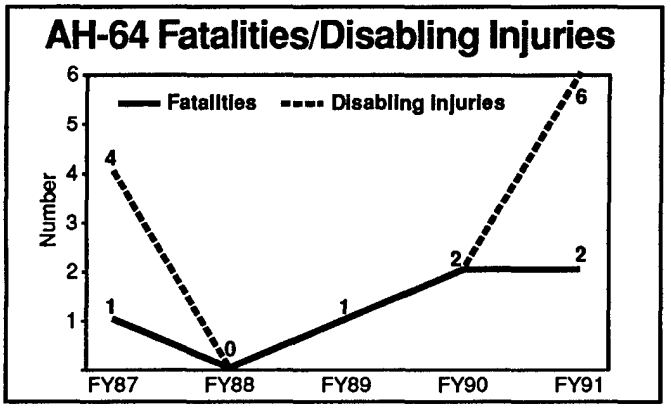


Figure 4-4

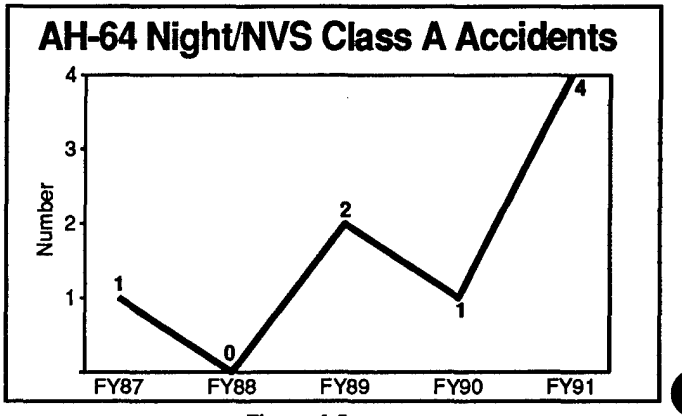


Figure 4-5

flying hours steadily increased, but Class A accidents did not.

Figure 4-3 shows the AH-64 Class A-C accident trend.

Figure 4-4 shows the fatalities and disabling injuries resulting from AH-64 accidents.

Figure 4-5 shows AH-64 Class A accidents that occurred at night. Note that in all 8 cases, crews were using NVSs.

Selected Class A accident briefs

Power loss

During a night tactical training mission, with NVS in use, the AH-64 lost engine power while at a 50-foot hover in a battle position. The IP attempted to obtain single-engine airspeed, but the aircraft contacted trees. It remained airborne for 2,100 meters before hitting the ground. The aircraft was destroyed. The IP sustained disabling injuries; the rear-seat pilot was only bruised.

Result: **One disabling injury, a destroyed aircraft, and a cost of $10,725,200.**

Cause: **Loss of engine power and inadequate crew coordination.**

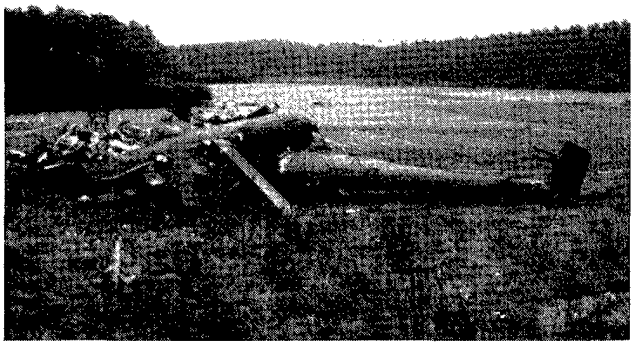
Cause: Suspect the engine power loss was caused when Np failed low on the number 2 engine. The IP, in the copilot/gunner (CPG) station, took the aircraft controls while he was set up with weapons symbology instead of flight symbology on his NVS. During the subsequent loss of engine power, he was denied flight information that might have assisted him in aircraft control. However, there was no established requirement for the pilot on the controls to have flight symbology displayed on his NVS. The IP also failed to ask the rear-seat pilot for assistance. The IP's inadequate teamwork resulted from his habit of demonstrating emergency procedures as a single pilot and from the training he received in the one-pilot-station combat mission simulator (CMS).

Crew experience: The IP had 2,904 rotary-wing hours, 728 in AH-64s. The pilot had 578 rotary-wing hours, 170 in AH-64s.

Recommended actions: Army level: **Establish a requirement for the pilot on the flight controls at night to have flight symbology set on the NVS. Initiate action to modify the CPG station with a switch/button on the cyclic control that will permit the CPG to select the desired symbology. Establish a requirement to modify the CMS to accept input into the computer from power levers in both cockpit stations.**

Wire strike

The AH-64 crashed onto the top of a berm following a wire strike. The wire strike occurred during the return portion of a night, low-level, company deep-attack training mission using NVS. The accident aircraft was chalk 4 of a flight of four, with the first three successfully completing the wire crossing near the passage point.



Cause: **Crew failed to maintain clearance while crossing wires.**

Result: **Two fatalities, a destroyed aircraft, and a cost of $12,235,285.**

Cause: The crew failed to comply with the minimum obstacle clearance of 100 feet established by the company commander prior to the flight. Additionally, the crew did not comply with TC 1-214 guidance in that they flew below 100 feet agl at a speed of 100 knots or more. This speed reduced the time available to see, identify, and avoid obstacles.

Crew experience: The pilot had 568 rotary-wing hours, 389 in AH-64s. The copilot/gunner had 1,639 rotary-wing hours, 796 in AH-64s.

Recommended actions: Army level: **Procure an obstacle-avoidance device for the AH-64 helicopter. This device should also be used in other tactical rotary-wing aircraft that commonly operate in terrain-flight mode.**

Materiel failure

Immediately after takeoff for a test and experimentation command mission, the crew heard a rumbling sound coming from aft of the rear-seat pilot's station. The sound was closely followed by a medium-frequency vibration felt through the airframe. The takeoff was aborted and the aircraft was landed to the right of the runway. Smoke was noted coming from the rear of the aircraft. The crew egressed uneventfully and quickly moved away from the aircraft. No attempt was made to fight the fire with onboard fire extinguishing systems. Firetrucks from the post fire station responded and put out the fire.

Cause: **Failure of duplex bearing in forward end of power takeoff clutch due to lack of lubrication.**

Result: **Aircraft damage cost of $1,923,133.**

Cause: The cause of the rumbling noise was failure of the duplex bearing in the forward end of the power takeoff clutch. Suspected cause of the bearing failure is lack of lubrication.

Crew experience: The pilot had 1,024 rotary-wing hours, 240 in AH-64s. The copilot/gunner had 424 rotary-wing hours, 254 in AH-64s.

Recommended actions: Army level: **Study the feasibility of replacing the power takeoff clutch forward seal with a seal designed to keep lubrication in and contaminants out.**

Failure to follow checklist

During a training flight, the AH-64 experienced loss of directional control due to loss of the tail rotor assembly. After the IP autorotated into a grove of pine trees, the aircraft was consumed by a postcrash fire.

Result: **One fatality, one major injury, a destroyed aircraft, and a cost of $11,289,867.**

Cause: During the preflight inspection, the crew failed to stow the door-locking device as required by the checklist. During flight, the unsecured door-locking device struck a tail rotor blade, which caused tail rotor system imbalance, complete tail rotor separation, and a loss of directional control. Contributing to the severity of injuries was the fact that the AH-64 restraint system does not provide an automatic-lock capability based on G forces other than longitudinally, which allows excessive lateral body movement.

Crew experience: The IP had 1,162 rotary-wing hours, 262 in AH-64s. The pilot had 3,184 rotary-wing hours, 50 in an AH-64.

Recommended actions: Unit level: **Inform pilots of the importance of completing all items on the checklist and the dangers of disrupting checklist sequence.** ***Higher level:*** **Attach "REMOVE BEFORE FLIGHT" flags to and/or paint all door-locking devices in accordance with AVSCOM instructions.** ***Army level:*** **Establish and publish procedures for stowing the AH-64 door-locking device and any future flyaway gear. Expedite the installation of the inflatable body- and head-restraint system. Improve APU mount or strengthen the aft fuel cell access plate.**

Materiel failure

During ground taxi operations, a fire began in the auxiliary power unit (APU) area and spread throughout the catwalk-turtleback area. Within seconds of APU start, the master caution and APU fire light illuminated. The APU fire handle was pulled and the fire extinguisher selector switch was placed in the primary and then reserve position, but the fire extinguishing agent did not dispense. The fire was extinguished by portable fire extinguishers and by firetrucks.

Result: **Aircraft damage cost of $1,500,000.**

Cause: A malfunction of the APU fuel shutoff solenoid allowed fuel to ignite in the transmission catwalk area. Contributing to the extent of damage was the fact that the onboard fire suppression system did not function when activated. In addition, the crew's attention was directed to maintaining clearance in a congested area, which caused a delay in detecting the fire. The fire suppression system wiring, which is not shielded, was burned, disabling the system.

Crew experience: The maintenance test pilot had 520 hours in AH-64s. The copilot/gunner station was occupied by a technical observer.

Recommended actions: Army level: **Determine whether this failure was an anomaly or supports a history of similar failures. Change the AH-64 operators manual to prohibit starting the APU until the aircraft has come to a stop and is parked. Incorporate a change in the maintenance manual requiring that the APU shutoff solenoid and APU fuel lines be inspected for leaks, with the APU in operation, during each 10-hour/14-day preventive maintenance service. Consider replacing electrical wiring that activates the onboard fire extinguishing system with wiring that is shielded.**

Failure to maintain stabilized hover

While hovering at night using the pilot night vision system (PNVS), the IP allowed the tail rotor to hit a 29-foot-high tree. The resulting tail rotor

failure caused a loss of antitorque control. Without antitorque thrust, main rotor torque caused the aircraft to abruptly yaw right. Simultaneously, the aircraft descended, striking the ground on its left main gear. It slid laterally for 4 feet until it came to rest.

Cause: **Crew failed to maintain a stabilized hover due to improper division of attention.**

Result: **Damage cost of $10,000,000.**

Cause: The crew failed to maintain a stabilized hover over a point. The IP at the controls was trying to maintain aircraft control while monitoring the movement of other aircraft and concerning himself with perceived anomalies in the aircraft's visual symbology. The pilot was inputting data into the doppler navigation system rather than assisting the IP in obstacle clearance. Fatigue played a part as both crewmembers had exceeded the allowed crew duty period for the past 48 hours.

Crew experience: The IP had 4,768 rotary-wing hours, 270 in AH-64s. The pilot had 425 rotary-wing hours, 109 in the AH-64.

Recommended actions: **Inform all personnel on how inattention, the environment, and fatigue can lead to accident-causing errors. Take positive command action to ensure personnel are proficient in performing tasks required of them.**

Selected Class B accident briefs

Failure to maintain stabilized hover

During gunnery training, the AH-64 was hovering out of ground effect (OGE) at a firing point. Unnoticed by the IP and pilot, the aircraft drifted 329 feet rearward and descended to 60 feet agl, where all four main rotor blades struck a tree. The IP took the controls and landed the aircraft.

Result: **Damage cost of $253,060.**

Cause: The IP and pilot failed to notice the aircraft drift from the original hover point and begin an inadvertent descent. The crew failed to properly divide their attention between the tasks associated with target engagement and those associated with aircraft control.

Crew experience: The IP had 4,250 rotary-wing hours, 912 in AH-64s. The pilot had 1,400 rotary-wing hours, 501 in AH-64s.

Recommended actions: **Inform all personnel of the facts and circumstances surrounding this accident and the lessons to be learned.**

Compressor failure

The crew was preparing for a running takeoff when the rated student pilot (RSP) noted a flickering master caution light accompanied by a flickering ACC OIL PSI PUMP segment light. The IP took the controls and returned to parking. When the auxiliary power unit (APU) was engaged, smoke billowed from the aircraft. During a panicked egress, the RSP kicked the cyclic from the IP's hand, and the main rotor struck the pilot night vision system (PNVS) turret.

Result: **Damage cost of $185,889.**

Cause: The shaft driven compressor (SDC) failed, causing the master caution and ACC OIL PSI PUMP segment lights to flicker. The SDC failed because the bearing and oil slinger had failed, pumping approximately 2½ gallons of transmission oil overboard. The IP shouted loudly and urgently to the RSP, who was "in the bag" and could not see outside the cockpit, to "get out, we're on fire!" In his panicked egress, the RSP kicked the cyclic from the IP's hand.

Crew experience: The IP had 3,648 rotary-wing hours, 404 in the AH-64. The RSP had 211 rotary-wing hours, 29 in AH-64s.

Recommended actions: Unit level: **Remind personnel of the importance of calm communications, especially when the recipient is "in the bag" and unable to see and judge for himself the urgency of a situation.** ***Army level:*** **Redesign the SDC to provide the required volume and rate of pressurized air with improved reliability and reduced hazard from overheating.**

Selected Class C accident briefs

Individual/training failure

As the AH-64 was completing a roll-on landing to the runway, the copilot/gunner (CPG) elected to slow the aircraft using aerodynamic braking. As he increased collective and simultaneously applied aft cyclic, a crunching sound was heard and a jolt was felt. The CPG further increased collective, bringing the aircraft to a hover over the runway. The pilot-in-command took the controls and hovered toward the sod. After turning on the landing light, the shadow of the 30mm cannon revealed that it was hanging below the aircraft. Two caution lights illuminated, the UTILITY LOW and UTILITY PSI.

Result: **Damage cost of $79,926.**

Cause: The pilot-in-command failed to ensure the aircraft was in a "weapons systems—safe" condition for landing as required by the operators manual. Due to a training deficiency, neither crewmember realized that the high-action display and associated weapons-status messages would be

deleted from aircraft displays when the CPG sight-select switch is in the NVS position and the pilot ground switch is in the override position.

Crew experience: The pilot-in-command had 1,036 rotary-wing hours, 282 in AH-64s. The CPG had 373 rotary-wing hours, 205 in the AH-64.

Recommended actions: Unit level: **Develop a training program that allows the CPG to maintain flying skills within the design limits of the aircraft. Define specifically the actions crewmembers are to take to comply with the before-landing check "weapons systems—safe."**

Failure to maintain stabilized hover

The rated student pilot (RSP) was attempting to stabilize the AH-64 at a hover in preparation for a confined-area landing when he allowed the aircraft to drift aft into a tree.

Result: **Damage cost of $40,148.**

Cause: The RSP paid improper attention and allowed the aircraft to drift aft. The SIP's attention was distracted while he was switching from TADS to HMDTADS and the aircraft drifted before he could react.

Crew experience: The SIP had 5,592 rotary-wing hours, 1,401 in AH-64s. The RSP had 1,336 rotary-wing hours, 40 in the AH-64.

Recommended action: **Inform all personnel of the facts and circumstances surrounding this accident and the lessons to be learned.**

Materiel failure

While ground taxiing to parking after completion of a maintenance test flight, the aircraft's 30mm gun barrel contacted a centerline taxiway light on a high-speed taxiway. The aircraft was pushed about 1 foot into the air by the pole-vaulting action of the gun. The gun and mount separated from the aircraft and lodged under the right main landing gear, causing the aircraft to rest left-side low. A fine spray of hydraulic fluid was coming from the forward underside of the aircraft.

Result: **Damage cost of $74,000.**

Cause: The copilot/gunner (CPG) fire-control panel and the type I MRTU failed, sending a false signal to the turret control box commanding the 30mm gun to depress. The gun remained depressed through landing and ground taxi until it contacted the centerline taxiway light.

Crew experience: The maintenance test pilot examiner had 1,173 rotary-wing hours, 597 in AH-64s. The maintenance test pilot had 2,716 rotary-wing hours, 291 in AH-64s.

Section V

MH/CH-47D Safety Performance Review

The MH/CH-47D was involved in 8 Class A accidents, 4 Class B accidents, and 24 Class C accidents during the FY 87 through FY 91 time period. These accidents resulted in 22 military fatalities and 15 disabling injuries. The MH/CH-47D cumulative Class A-C accident rate for the period was 19.64 per 100,000 flying hours based on a total of 183,305 hours, compared to the total rotary wing cumulative Class A-C rate of 3.43.

The leading cause of MH/CH-47D accidents continues to be human error. Findings in the 8 Class A accidents were distributed as follows: 8 individual failures, 1 leader failure, and 3 materiel failures. (Keep in mind that each accident may have more than one cause factor.)

Of the three materiel failures, one involved the engine transmission input pinion gear, one involved failure of the combining transmission pinion gear, and one involved fatigue failure of the riveted end of the number-2 engine drive shaft adapter.

Of the eight Class A accidents, four occurred at night. In all but one night accident, the aircrews were using night vision devices (NVDs); in one of these cases, NVDs were in use in the cockpit but not in the cabin area.

During Operations Desert Shield/Desert Storm, the MH/CH-47D accounted for 2 of the 29 Class A accidents (not including combat losses). Neither MH/CH-47D accident occurred at night.

Accident experience

MH/CH-47D accident experience reflects the historical profile of all other Army aircraft. With each aircraft, problems have been encountered with system reliability and maintenance during the initial development and fielding cycle. Figures 5-1 through 5-5 depict MH/CH-47D trends over the 5-year period. Note that trends may appear skewed in FY 91 due to Operations Desert Shield/Storm.

Figure 5-1 shows a significant increase in MH/CH-47D flying hours through FY 91.

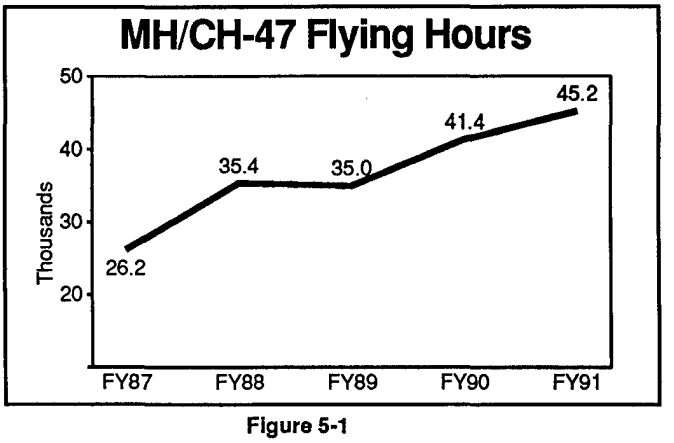


Figure 5-1

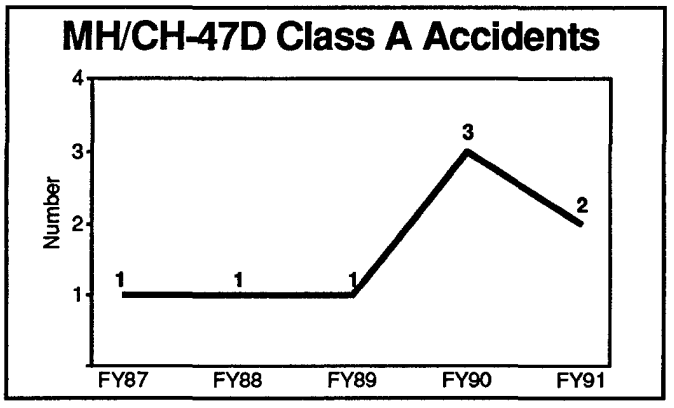


Figure 5-2

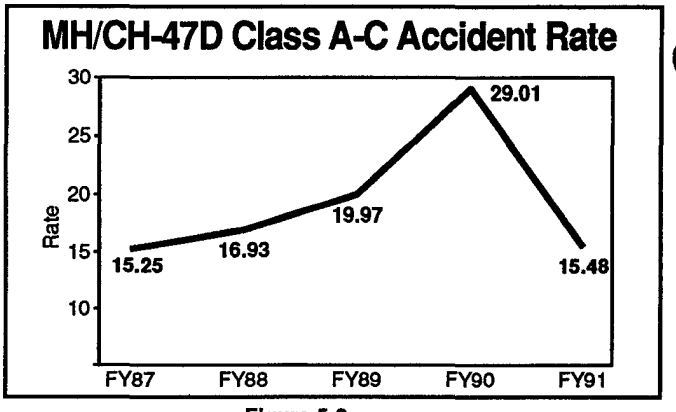


Figure 5-3

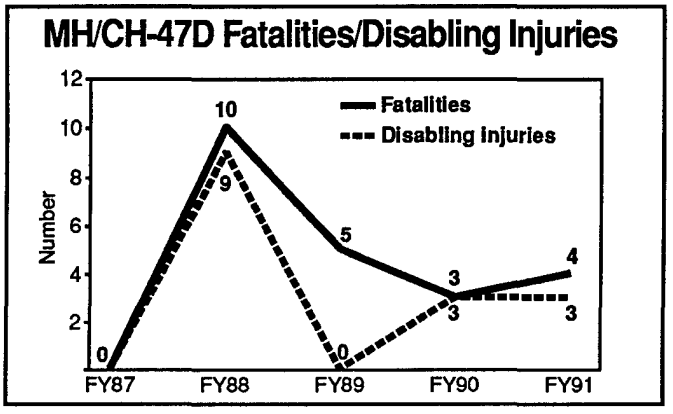


Figure 5-4

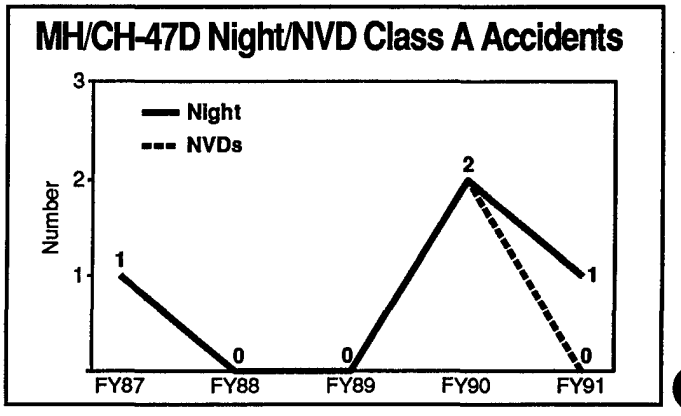


Figure 5-5

Figure 5-2 shows MH/CH-47D Class A accidents during the 5-year period.

Figure 5-3 shows MH/CH-47D Class A-C accident rates per 100,000 flying hours.

Figure 5-4 shows the fatalities and disabling injuries resulting from MH/CH-47D accidents.

Figure 5-5 shows MH/CH-47D Class A accidents that occurred at night. Note that in 3 of the 4 cases, NVDs were in use.

Selected Class A accident briefs

Drive-train failure

While in cruise flight at 3,000 feet msl, the crew heard a pop then a loud explosion. Witnesses saw fire and smoke in the rear of the aircraft and several parts falling to the ground. Smoke filled the cabin and entered the cockpit, and the aircrew initiated an emergency descent. The aircraft hit the ground in a landing attitude at about 130 knots.

Result: **10 fatalities, a destroyed aircraft, and a cost of $8,155,033.**

Cause: The drive train from the No. 2 engine failed. Because procedures in the operators manual did not provide adequate guidance and the pilot had never practiced or attempted a similar maneuver, he was late in his attempt to decrease forward airspeed and rate of descent.

Crew experience: The PC had 4,228 rotary-wing hours, 165 in the CH-47D. The PI had 2,929 rotary-wing hours, 116 in the CH-47D.

Recommended actions: **Convene a task team of appropriate agencies to study possible failure modes and scenarios and develop corrective actions. Improve emergency descent procedures in the operators manual.**

Materiel failure

About 5 minutes into the second leg of a service mission, while in cruise flight at 500 feet msl, the aircraft caught fire in the left side area of the aft pylon. The fire spread rapidly, engulfing the entire pylon. Drive from the No. 1 engine was lost, and the crew initiated an emergency descent. The aircraft became uncontrollable and was observed to roll left, then right, followed by a nose-down roll to the left just before impact. The aircraft came to rest on a 21-degree downslope, oriented in a direction opposite the direction of flight. The aircraft was destroyed by fire.

Result: **Five fatalities, a destroyed aircraft, and a cost of $13,038,403.**

Cause: The No. 1 input pinion of the combining transmission failed. Fire caused by the cracked pinion housing melted the flight controls, which were not designed to withstand the heat of the fire.

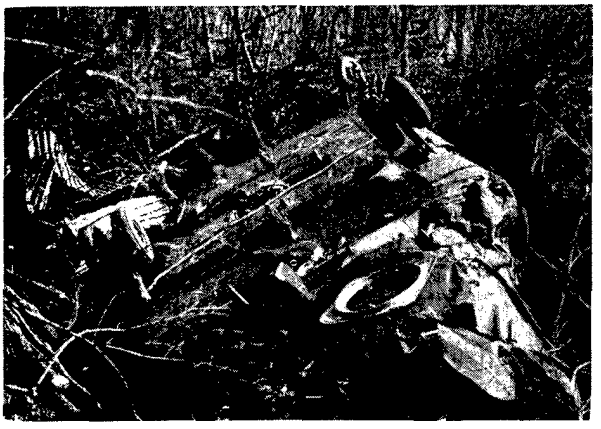
Crew experience: The PC had 3,226 rotary-wing hours, 319 in the CH-47D. The PI had 322 rotary-wing hours, 79 in the CH-47D.

Cause: **Failure of No. 1 input pinion of combining transmission.**

Recommended actions: **Continue to evaluate the reason for the pinion gear failure. Install a fire detection/extinguishing system in the combining and engine transmission areas of all CH-47 aircraft. Install stainless steel flight control rods throughout the tunnel area, and conduct a study into the susceptibility to fire of other control components, mounting structures, and the airframe on all CH-47 helicopters.**

Human error

The CH-47D was on a day, low-level, VFR training mission with a slingload. While ascending a draw to cross a ridge, the aircraft entered a cloud layer and the crew lost visual ground reference. The crew initiated proper emergency procedures, but by the time contact was reestablished with the ridge, collision was unavoidable. The aircraft struck a 44-degree slope in a near-level attitude. Rotor blade contact with trees and the ground caused the aircraft to roll inverted and slide down the ridge about 120 feet.



Cause: Human error.

Result: **No fatalities or serious injuries, a destroyed aircraft, and a cost of $13,007,160.**

Cause: The IP's poor flight-route selection required crossing the highest terrain feature in marginal weather. The crew failed to act on information that weather conditions were worse than indicated during the weather briefing and first-hand knowledge from having negotiated the same ridge less than an hour before the accident.

Crew experience: The SP had 3,902 rotary-wing hours, 350 in the CH-47D. The PI had 1,038 rotary-wing hours, 54 in the CH-47D.

Recommended actions: **Inform all personnel of the circumstances of this accident, with emphasis on how inattention, overconfidence, and the environment can lead to accident-causing errors.**

Failure to follow procedures

During a night training flight with NVGs in use, the aircraft was making an approach to a field site. The crew chief called out that load height was 75 feet as the pilot continued the approach. At about 50 knots airspeed and one kilometer short of the intended landing area, the pilot heard a loud noise and the aircraft pitched nose down. The slingload (a 15,760-pound concrete block) had contacted the ground, causing the aircraft to rapidly descend nose first. The IP took control of the aircraft and jettisoned the load as the aircraft hit the ground. The aircraft came to rest inverted. The pilot, crew chief, and flight engineer instructor (FEI) were killed. The copilot and the flight engineer sustained minor injuries. The aircraft caught fire during the crash sequence and was totally consumed by the flames.

Result: **Three fatalities, a destroyed aircraft, and a cost of $12,558,408.**

Cause: The IP allowed the copilot to fly the aircraft below a safe approach angle on approach, for reasons unknown. The copilot was relying on the crew chief to call out slingload height above the ground and on the IP to correct any deviation from standards. The crew chief reported the slingload was passing through 75 feet on descent, but it is not known why he did not continue to call out load height below this point.

Crew experience: The IP had 5,069 rotary-wing hours, 1,058 in the CH-47D. The PI had 1,081 rotary-wing hours, 770 in the CH-47D. The crew chief had 183 hours, the flight engineer had 278 hours, and the FEI had 1,598 hours in CH-47s.

Recommended actions: **Develop crew chief training tasks, conditions, and standards for assisting aviators by reporting load height for night slingload operations. Require that crew chiefs and flight engineers be tested for depth perception during every annual Class III flight physical.**

Materiel failure

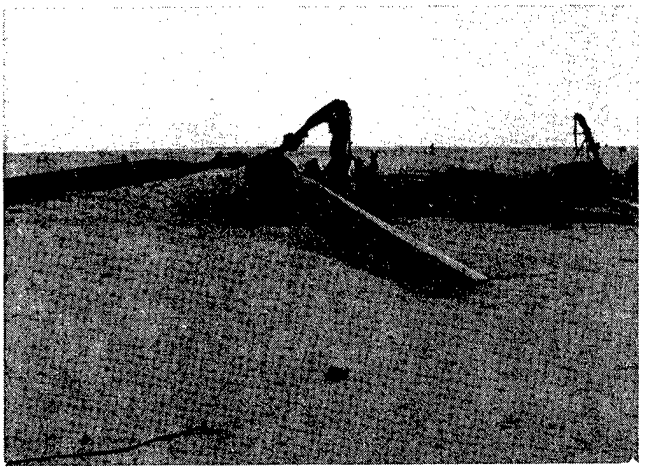
During a tactical low-level mission, the number-2 engine transmission hot caution light came on. During the emergency landing, the number-2 engine failed and caught fire. The aircraft landed, and the crew and passengers egressed as the pilot actuated the on-board fire extinguishing system into the number-2 engine. The aircraft was combat loaded with an M102 howitzer, an M998 HMMWV, and the personal and military equipment of the passengers and crew. The aircraft and cargo were totally consumed by the fire.

Result: **Two minor injuries, a destroyed aircraft and cargo, and a cost of $10,186,264.**

Cause: The engine failure resulted from failure of the engine transmission pinion drive gear due to a manufacturing defect. An engine fire resulted from a crack in the engine transmission housing (caused by the gear failure), which allowed hot oil and debris to be ingested by the engine. The engine, no longer connected to the drive train, oversped and failed.

Crew experience: The PC had 5,865 rotary-wing hours, 887 in the CH-47D. The PI had 3,135 rotary-wing hours, 100 in the CH-47D.

Recommended actions: **Stress the importance of detailed crew and passenger briefings to ensure that, in the event of an emergency, all personnel understand their duties and all avenues of egress. Stress to all CH-47 crews the importance of providing all possible avenues of egress to passengers occupying vehicles on aircraft during tactical moves. Improve quality control in the manufacturing process of the identified defective gears used in CH-47D transmissions.**



Cause: **Failure of engine transmission pinion drive gear.**

Human error

The aircraft was flying 250 feet agl at 120 knots at night along a prominent road. The crew failed to see a tower, which was marked on their map. The aircraft hit the tower 70 feet below the top and crashed. Four of five

Cause: **Aircraft struck tower at night.**

onboard personnel were killed, and the aircraft was destroyed.

Result: **Four fatalities, a destroyed aircraft, and a cost of $12,855,000.**

Cause: The crew's errors probably resulted from fatigue and environmental factors. The crew had been awake for 16.5 hours and actively engaged in the mission for 9.5. Their route of flight was generally into a full, bright moon, which was at about 10 degrees above the horizon. This may have partially obstructed their forward vision and was the influencing factor in the crew's decision not to use night vision goggles.

Crew experience: The copilot had 740 rotary-wing hours, the pilot had 2,690.

Recommended actions: **Ensure unit crew-rest policies present appropriate guidelines and that decisions to exceed them are subject to careful risk assessment and evaluation by the unit flight surgeon. Expedite efforts to field an obstacle avoidance system for installation in aircraft required to operate in the tactical environment.**

Selected Class B accident briefs

Failure to follow procedures

During departure from a stagefield while on an NVG training flight, the aircraft hit a 4-foot-square concrete block kept at the stagefield for use as a training load. The right front landing gear contacted the load, causing the aircraft to abruptly pitch nose-low. The pilot quickly attempted to bring the nose up, causing vibrations in the airframe. Because he perceived the vibrations to be severe, he elected to set the aircraft down. As the helicopter descended, the load penetrated the fuselage. The crew completed an emergency shutdown, and the crew and passengers exited the aircraft.

Cause: **Failure to follow procedures.**

Result: **No fatalities or injuries; damage cost of $157,072.**

Cause: The pilot failed to detect a large concrete block to his right front because his attention was focused on another aircraft in front of him. In addition, he was trying to combine NVG takeoff procedures with diagonal movement, which is contrary to established procedures.

Crew experience: The PC had 2,097 rotary-wing hours, 1,084 in the CH-47D. The PI had 1,904 rotary-wing hours, 362 in the CH-47D.

Recommended actions: **Emphasize how deviations from standards can result in crewmembers' attention being focused away from obstacle clearance.**

Crew error

The crew was performing an NVG approach 90 degrees to the long axis of a dusty runway. The crew failed to detect a 2-degree downslope in their intended landing direction, which, together with their forward speed at touchdown, prevented them from stopping the aircraft within the intended landing area. When the crew attempted a go-around, dust and darkness masked the barrier (a 4- to 5-foot-high berm) to their front. The aircraft struck the berm, causing lower airframe and externally mounted equipment damage.

Result: **No fatalities or injuries; damage cost of $392,231.**

Cause: The crew was overconfident since they had operated within the vicinity of this landing site before and perceived the site to be level. However, the crew's experience was with landings to the long axis of runway, which did not require consideration of runway slope. The crew failed to detect the berm to their front due to dust and darkness.

Crew experience: The PC had 3,836 rotary-wing hours, 2,697 in the CH-47D. The PI had 4,516 rotary-wing hours, 2,639 in the CH-47D.

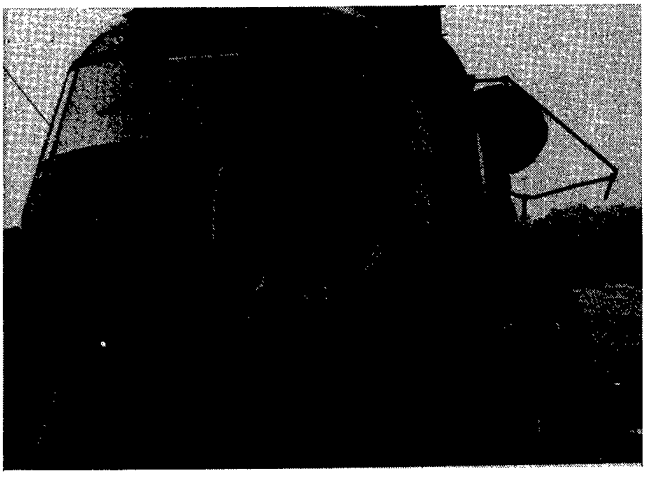
Recommended actions: **Inform personnel of how the crew's overconfidence in their own abilities contributed to the error. Consider on-site safety surveys of established training sites and, during pre-mission briefings, discuss safety hazards that could be encountered.**

Human error

While conducting a hooded night VFR extended downwind simulated non-precision approach (the local navaid was out of service) to an Army airfield, the aircraft descended into the trees. The IP regained control after impact and continued flight approximately 2 miles to the airfield.

Result: **No fatalities or injuries; damage cost of $266,031.**

Cause: The IP selected a minimum descent altitude (MDA) 300 feet below the published MDA that allowed the aircraft to strike trees. He had operated at that airfield before and had noted that 400 feet provided plenty of clearance. He failed to realize that by extending the downwind approach he had exited the traffic pattern and entered a training area containing trees.



Cause: **Overconfidence.**

Crew experience: The IP had 4,178 rotary-wing hours, 1,295 in the CH-47D. The PI had 2,629 rotary-wing hours, 50 in the CH-47D.

Recommended actions: **Inform all personnel of the circumstances of this accident with emphasis on how overconfidence can cause accidents.**

Selected Class C accident briefs

Maintenance error

The preflight inspection was conducted the day before the mission, with no discrepancies noted. On the day of the mission, a security check was conducted while removing covers and tiedowns. A final walk-around inspection covered the bottom of the aircraft only. While in flight at 2,500 feet msl, the lower latch on the clamshell door failed, and the doors opened. The upper latch failed instantaneously, and the clamshell doors were torn from the aircraft by aerodynamic pressure. Both engine inlet screens and one aft rotor blade were struck by the separating doors. The aircraft landed at a nearby airport.

Result: **No fatalities or injuries; damage cost of $36,367.**

Cause: In preparation for a 120-day deployment, the enlisted flight crew changed the clamshell door latch pins because of wear. No entries were made to the maintenance records, so the latches were never inspected by a unit technical inspector.

Crew experience: The PC had 1,987 rotary-wing hours, 553 in CH-47Ds; the PI had 825 rotary-wing hours, 152 in CH-47Ds. The flight engineer had 518 hours in the CH-47D, and the crew chief had 43.

Recommended actions: **Ensure that all aircraft that are preflighted the day before a mission are physically checked by the pilot or copilot to ensure that all cowlings and latches are secured. Emphasize the importance of documenting all maintenance that is performed.**

Materiel failure

During the engine start sequence for a maintenance test flight, the number-2 engine transmission clutch failed to engage. As engine shutdown was initiated, the number-2 engine sprag clutch suddenly engaged. This engagement resulted in the number-2 engine drive shaft being torque-twisted apart and exiting the aircraft. A large portion of the engine drive shaft struck the ground less than 2 feet from where the crew chief was standing in his duty position.

Result: **No fatalities or injuries; damage cost of $145,613.**

Cause: No. 2-engine transmission sprag clutch failed to engage during the start sequence, and, before the engine could be shut down, the clutch engaged.

Crew experience: The PC had 765 rotary-wing hours, 647 in the CH-47D. The PI had 664 rotary-wing hours, 575 in CH-47Ds.

Recommended actions: **The existing sprag clutch should be replaced with one by another manufacturer. Operators manual emergency procedures for clutch failures should be rewritten as required memorization and to include warnings of the possibility of clutch failure during the start sequence.**

Crew error

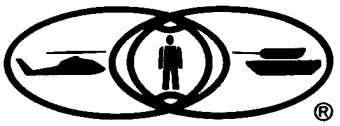
During four-wheel ground taxi under the direction of a ground guide, the pilot initiated a left turn. When obstacles appeared to be extremely close, the crewmember on the ramp became alarmed and attempted to warn the pilots. At this point it was too late; the aft rotor blades hit a light pole. The pilot immediately shut down the aircraft.

Result: **No fatalities or injuries; damage cost of $184,452.**

Cause: The pilots incorrectly judged the distance between the aft rotor system and the light pole. Enlisted crewmembers failed to actively participate in the ground taxi of the aircraft by providing timely information concerning obstacle clearance. They remained seated as the pilots began receiving commands from a ground guide.

Crew experience: The PC had 1,088 rotary-wing hours, 836 in the CH-47D. The PI had 596 rotary-wing hours, 306 in the CH-47D.

Recommended actions: **Inform all crewmembers of the circumstances of this accident, with emphasis on crew coordination and communication. Inform all crewmembers of the importance of actively participating in ground taxi procedures even when the aircraft is being directed by an outside ground guide.**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