FLIGHT SAFETY FOUNDATION
HELICOPTER SAFETY
Vol. 24 No. 6 *For Everyone Concerned with the Safety of Flight* November–December 1998

Helmets with Visors Protect Helicopter Crews, Reduce Injuries

Studies of accidents and equipment show that helmets with visors have played a significant role in protecting military helicopter pilots and other crewmembers from serious facial injuries. One study said that visors prevented injury or reduced the severity of injury in 25 percent of 459 U.S. Army accidents in which visor use was documented. The study said that more civilian helicopter operators should be informed about current technology in helmets and visors, and the availability of this safety equipment.

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U.S. military services train helicopter crewmembers to use aviation life-support equipment (ALSE) on every flight. Required ALSE safety items include, minimally, a Nomex® flight suit and gloves resistant to fire and chemicals, leather boots, and a helmet with visor. U.S. Army aeromedical researchers believe that the helmet with visor is the most critical ALSE component because numerous studies show that head injuries are the leading cause of death in U.S. Army helicopter accidents.[1]

Military helicopter crewmembers expect visors to provide protection from dust, wind, sun glare and particle fragments, and in the case of an accident, to prevent serious head injuries — including injuries to the face and eyes. The type of visor discussed in this article covers the face with a transparent material attached to a flight helmet. In typical designs, one visor or two visors can be worn either down over the face (deployed) or up (retracted into the helmet). The impact resistance of current-technology visors also has protected civilian pilots from injury.

One bird strike described to U.S. Army aeromedical researchers, for example, involved a law-enforcement helicopter flying over Florida in the United States. A large hawk appeared suddenly and penetrated the cockpit. The pilot, wearing his visor down, was struck by unspecified debris and spattered by remains of the bird. The visor protected his face and his vision, and the pilot recovered quickly from the impact and landed the aircraft safely. The visor was part of the safety equipment issued by the law-enforcement agency and worn by a pilot who recognized the value of this protection.

The structural integrity of modern helicopter cockpits and cabin areas has become more likely to be maintained when a helicopter strikes the ground with abnormally high force, preventing injuries or reducing the severity of injuries.[2] Fuel systems, seats and occupant restraints have been improved — and airbags have been installed in some aircraft.

With the increased survivability of helicopter accidents, some researchers have asked more questions about the survivors. Were any of the injuries preventable? How could injuries have been minimized? U.S. Army aeromedical researchers believe that several data sources support the consistent use of personal safety equipment as a reliable way to prevent injuries and minimize the severity of injuries. The primary agencies

maintaining the relevant databases are the U.S. National Transportation Safety Board (NTSB) and the U.S. Army Safety Center (USASC), Fort Rucker, Alabama, U.S.

Visors Evolved from Improved Helmet Designs

The earliest airplane accidents showed the need for personal safety equipment to prevent or reduce the severity of head injuries. Initially, only leather-and-cloth football helmets were available to pilots for this purpose. Simple goggles with glass lenses were used by some pilots for eye protection. Some pilots wore soft leather helmets that primarily provided protection from cold temperatures, wind, rain and insects. Other pilots recognized the need for impact protection and wore industrial-type, hard-shell helmets. A military-accident investigation in 1913 showed that one of two U.S. Army Signal Corps pilots, for example, escaped serious injury because he was wearing a helmet.[3] A steel flight helmet was designed for experimental use near the end of World War I.[4]

In the following decades, the U.S. Army developed several flight helmets. Many improvements were based on aeromedical researchers' analysis of helmets, visors and wearers' injuries in helicopter accidents. In 1959, various hard-shell helmets were replaced by a general-purpose flight helmet with a compressible liner, called the aviator protective helmet or APH-5. The APH-5 provided minimal hearing protection, but significantly reduced head injuries.

The evolution of U.S. Army helmets included the sound-protective helmet (SPH-4) in 1969 (modified in 1974 and 1982), the improved-sound helmet (SPH-4B) in 1989, the integrated helmet and display-sighting system (IHADSS) developed specifically for the McDonnell Douglas (now Boeing) AH-64 Apache helicopter in 1984, and the headgear unit (HGU-56/P) in 1995.

Laboratory testing, crewmember reports and accident data led to helmet changes such as stronger, lighter shell materials, additional hearing protection, crushable earcups to absorb impact forces, better fitting-and-retention (chin-strap) technology, and more impact-resistant visors and liner systems.

[FSF editorial note: Civilian versions of three military flight helmets with visors are available: the SPH-5 (equivalent to the military SPH-4B except for a nylon-graphite shell in place of a Kevlar®-graphite shell, and a dual polycarbonate-visor assembly instead of a single polycarbonate visor); the HGU-56 (equivalent to the U.S. Army's latest model); and the HGU-84 (equivalent to a helmet used by helicopter crews in the U.S. Navy and U.S. Marine Corps).[5] The photographs, right, show the SPH-5 dual-visor helmet and the HGU-84 dual-visor helmet.]

Most of the military helmets, except the HGU-56/P, are available to civilians through military-surplus suppliers. U.S. Navy and U.S. Air Force flight helmets for helicopter crewmembers, which are different versions of the SPH and HGU series, also are available as surplus equipment.

Civilian versions of three U.S. military flight helmets with visors currently include the SPH-5 (upper photo) and the HGU-84 (lower photo). Several types of military helmets with visors are available to civilians through military-surplus suppliers. (Source: Flight Suits)

Visors have been an important component of helmet-safety technology. Current visors usually are fabricated from acrylic

plastic or polycarbonate materials, and are either clear or tinted. Polycarbonate is the latest material preferred because of greater impact resistance.

Visors for helicopter pilots typically are mounted within a visor housing on the flight helmet. Depending on the type of helmet, this housing holds either a single visor or two separate visors. The APH-5 helmet and the SPH-4 helmet have a single-visor housing, requiring the pilot to remove and replace the visor with the desired type, usually before flying. The SPH-4B helmet and the HGU-56/P helmet have a dual-visor housing, permitting immediate selection and use of either visor or both visors.

Accident Data and Equipment Studies Show Effectiveness of Visors

Some helicopter pilots have underestimated the effectiveness of visors. Nevertheless, the effectiveness of visors in preventing serious facial injuries — including blinding eye injuries — has been well documented in accident reports of the USASC, the U.S. Federal Aviation Administration (FAA) and NTSB. In addition to these investigative agencies, the Aviation Life Support Equipment Retrieval Program (ALSERP), established by the U.S. Army in 1973, monitors the effectiveness of life-support equipment. ALSERP requires that all ALSE items damaged (even partially) during military-aircraft accidents be retrieved for analysis. The photograph, right, shows damage to a visor that was sent to this program. ALSERP also evaluates personal safety equipment for other government agencies (such as the U.S. Coast Guard and the U.S. Bureau of Indian Affairs). ALSERP is operated by the U.S. Army Aeromedical Research Laboratory (USAARL).

To investigate the effectiveness of visors in U.S. Army rotary-wing accidents, USAARL researchers in late 1997 conducted a search of the USASC data on U.S. Army rotary-wing accidents, moderate-to-severe categories (Class A–Class C), in fiscal years 1990–1996.[6]

The initial data included 1,035 accidents in which flight helmets with visors were worn. Visors were used in 459 of these accidents (Figure 1, page 4). The investigators determined that visors prevented injury in 102 accidents (22.2 percent) and reduced injury in 13 accidents (2.8 percent). Thus, visors prevented injury or reduced injury severity in approximately 25 percent of the U.S. Army helicopter accidents in which visor use was documented.

The following case histories, from narratives written by accident investigators, were among several that USAARL researchers believed were pertinent to their study of visors.

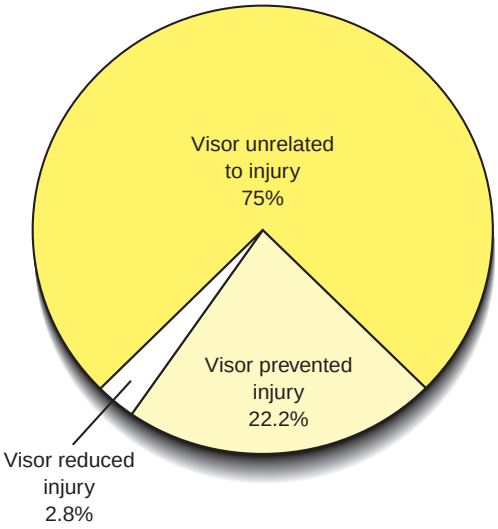
Case 1 (Boeing AH-6): "In an attempted right break from a shallow dive, the low-rotor-rpm (revolutions per minute) audio was activated. The pilot [flying] attempted to decelerate and level the aircraft and arrest the descent. The aircraft struck the ground in a nose-high [attitude] and rolled and came to rest on [the aircraft's] right side. The aircraft sustained extensive damage. The pilot was wearing an SPH-4 helmet with a tinted visor that he was not using. [Instead of the visor] he was wearing tinted nonprescription glasses. His helmet was scratched and his glasses were dislodged and separated. The pilot-in-command, who also was wearing an SPH-4 [helmet], but was using his tinted visor, was treated [for] a minimal laceration to his right cheek due to a blow to his helmet that scratched the helmet and the face piece of the visor. The visor was cited as producing the laceration injury, but also was cited as preventing a more serious injury."[7]

The U.S. Army's Aviation Life Support Equipment Retrieval Program (ALSERP) analyzes all damage to equipment — such as damage to the tinted visor on this helmet — following military-aircraft accidents. (Source: U.S. Army Aeromedical Research Laboratory)

Case 2 (Bell UH-1): "A UH-1 experienced a left yaw with the nose of the aircraft tucking down. The pilot responded with a reduction of power and initiated landing, but he had a negative response. The aircraft [struck the ground] hard and slid into trees. The three crewmembers were all wearing SPH-4 helmets and using their visors. All three helmets were scratched and indicated evidence of blows to the head. All personnel were using their visors, which were cited as reducing the level of injuries."

Although quantitative information about visors has been limited in accident reports, ALSERP's study of damaged safety

Role of Visors in Preventing Injuries or Reducing Injury Severity in U.S. Army Helicopter Accidents, Fiscal Years 1990–1996

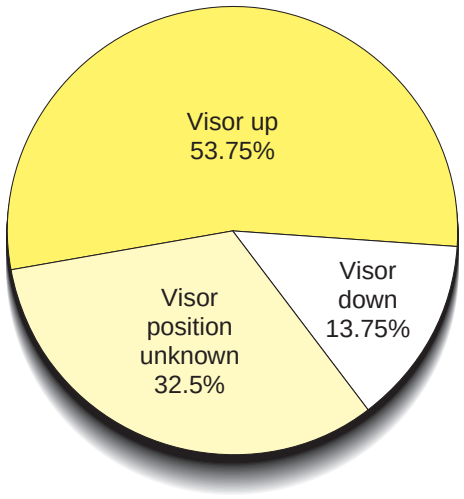


Note: The researchers reviewed 1,035 helicopter accidents in which records showed that a helmet was used. Of these accidents, records showed that visors were used in 459 accidents.

Source: U.S. Army Aeromedical Research Laboratory

Figure 1

Position of Visors in U.S. Army Helicopter Accidents, Fiscal Years 1990–1996



Note: The researchers reviewed 80 accidents, studying damage to visors worn by 55 pilots and 25 air crewmembers, and related life-support-equipment data.

Source: U.S. Army Aeromedical Research Laboratory

Figure 2

equipment from military-helicopter accidents has provided additional information. In an analysis of ALSERP data collected during fiscal years 1990–1996, USAARL researchers studied information from 80 military accidents. The data included ALSE information for 55 pilots and 25 other crewmembers who were wearing one of the four standard flight helmets. Visor information could not be collected for some of the 80 accidents because of postaccident fires and other damage, but the data available indicated that the majority of the crewmembers — 70.8 percent — experienced some degree of head, neck or facial injury.

USAARL researchers examined all retrieved helmets to determine the visor position at the time of aircraft impact. Figure 2 shows that 53.8 percent of the helmets had visors in the up position. Some of these helmets were worn by crewmembers who were flying with night-vision goggles (NVGs). (Because the visor cannot be deployed while using NVGs, the visor was assumed to be in the up position.) Figure 2 shows that 13.8 percent of the crewmembers were wearing a visor in the down position during the accident.

Helmets and visors that were too badly damaged to yield information on visor position were classified as "visor position unknown." Among the accidents in which the visor position was known, USAARL researchers found that the incidence of head/neck injuries experienced by crewmembers in both categories — visor up and visor down — was identical (70 percent) but the severity of injuries varied significantly.

Crewmembers who wore their visors down sustained minor facial injuries — caused by the visor in many cases (often due to the visor edge striking the cheek) — but there were fewer fatalities among them. The data showed 18.2 percent fatalities among the crewmembers with visors down versus 53.5 percent fatalities among crewmembers with visors up. This finding is consistent with a 1988 study that found fatality rates of 26 percent among pilots with visors down and 34 percent among pilots with visors up.[8]

USAARL researchers concluded from these studies that visors on flight helmets designed for rotary-wing aircraft crews play a major role in reducing the incidence and severity of facial injuries among military crewmembers.

Nevertheless, for civilian helicopter pilots, safety-equipment issues are more complex. Because of the diversity of operations, the equipment used by civilian pilots and other crewmembers varies. In many operations, the employer requires and provides the safety equipment to be worn; in some settings, nearly all flight-safety decisions are based on the professional judgment of individual pilots.

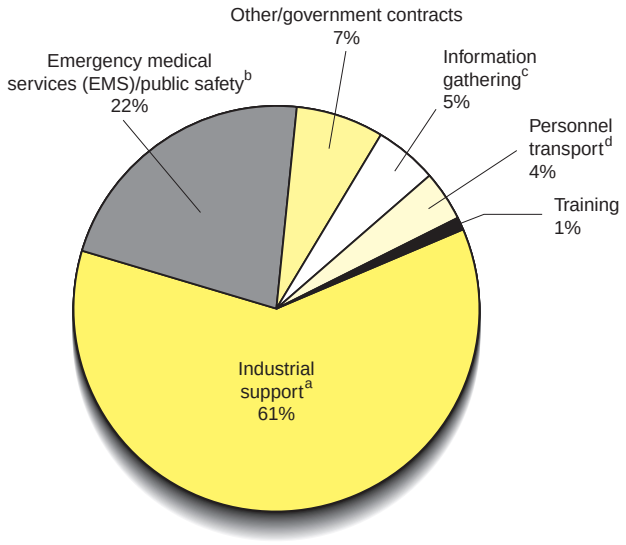
According to 1997 data compiled by Helicopter Association International (HAI), approximately 6,300 helicopters were active

in the United States.[9] Figure 3 shows HAI's estimates of percentages of civilian-helicopter utilization in various categories. The principal use of civilian helicopters — 61 percent — was industrial support, which includes agriculture, logging and construction. The second-largest use — 22 percent — was emergency medical services (EMS) and public safety.

USAARL researchers contacted representatives of several civilian helicopter operators to informally assess visor use. Businesses, government agencies and professional associations throughout the United States provided information that showed that visor use varied from mandatory use to no use.

Many government agencies (local, state and federal) said that they enforce policies that require helmet use and visor use by helicopter pilots. Law-enforcement agencies, conservation departments and construction companies typically said that wearing a flight helmet with the visor deployed was "just good common sense." Pilots for construction companies and logging companies, who fly low-altitude operations with their heads outside the cockpit, typically said that visors worn down provide protection from dust and backwash debris, making visors a practical necessity.

Distribution of Civilian Helicopter Operations in the United States, 1997



[a] Industrial support includes agriculture, logging/lumber, utility support, oil and gas support, and construction.

[b] EMS/public safety includes firefighting, public service/safety and law enforcement.

[c] Information gathering includes engineering, traffic control and aerial photography.

[d] Personnel transport includes on-demand operators, corporate flights and tour operators.

Source: U.S. Army Aeromedical Research Laboratory and Helicopter Association International

Figure 3

Several rotary-wing pilots at law-enforcement agencies, fish-and-game departments, and forestry services also said that they believe that visors are vital safety tools. Regarding bird strikes, each agency contacted by USAARL researchers described numerous incidents in which a bird strike had compromised flight safety, and safety equipment had helped to prevent accidents.

The following accident, which involves an airplane, shows the hazard of a bird strike: A U.S. Coast Guard instructor-pilot and student were flying a Beech T-34C on a routine training flight. A bird struck the front windshield, entered the cockpit and then struck the instructor-pilot in the face. The instructor-pilot did not have his visor down, and the impact of the bird rendered him unconscious. The student landed the aircraft safely. Facial injuries to the instructor-pilot caused a major vision impairment in one eye, ending his career as a U.S. Coast Guard pilot.

Other documented incidents show that facial injuries, unconsciousness and brain injury can result from a bird strike. Several helicopter pilots interviewed by USAARL researchers said that they believe that visors can prevent injuries or minimize injuries in bird strikes.

The USAARL researchers heard a different viewpoint expressed by some of the on-demand helicopter operators, EMS helicopter operators and other commercial helicopter operators. One pilot said that wearing a helmet with a visor was like "flying while looking through a toilet-paper tube." Several other civilian pilots — including some military-trained pilots — said that they do not wear helmets or visors because they prefer the "freedom" of wearing sunglasses and a headset. Other pilots said that personal safety equipment is not cost effective in civilian operations; that helmets and visors "send the wrong message to passengers" (that is, the equipment would cause unwarranted anxiety among nonhelmeted people in the aircraft); that this type of equipment is too costly for individuals if not provided by the employer; and that the equipment may increase fatigue, distort vision and restrict movement.

Full discussion of these viewpoints is outside the scope of the USAARL researchers' study of visor effectiveness in military accidents. The risk factors in any type of flying should be evaluated by helicopter operators and pilots in light of the latest safety information. Nevertheless, the opportunity for civilians to benefit from some of the latest helmet technology and visor technology should not be underestimated among the options for improving aviation safety.♦

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5. The manufacturer of these military and civilian flight helmets is Gentex Corp., Carbondale, Pennsylvania, U.S.

6. Class A accidents involve US$1 million or more property damage and/or destruction of a U.S. Army aircraft, missile or spacecraft and/or a fatality or permanent total disability. Class B accidents involve $200,000 or more property damage but less than $1 million property damage, and/or permanent partial disability and/or five or more people hospitalized as inpatients. Class C accidents involve $10,000 or more property damage but less than $200,000 property damage, and/or a nonfatal injury resulting in loss of time from work beyond the workday or shift when the injury occurred, or a nonfatal illness or disability that causes loss of time from work.

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