FLIGHT SAFETY FOUNDATION
HUMAN FACTORS & AVIATION MEDICINE

Vol. 50 No. 1 *For Everyone Concerned With the Safety of Flight* January–February 2003

Compliance With Safety Practices Is Best Method of Avoiding Eye Injuries

Loss of vision can be caused by exposure to chemicals and radiation, as well as trauma to the eye. Specialists say that with proper precautions, more than 90 percent of eye injuries could be prevented.

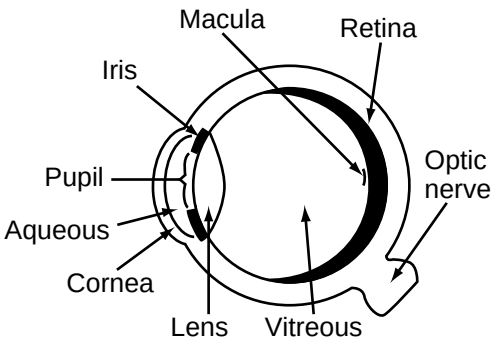
Clarence E. Rash
Sharon D. Manning

Every year, more than one of every 1,000 people in the world experiences a significant eye injury.[1,2] Worldwide, eye injuries have resulted in blindness for about 1.6 million people and in low vision (varying amounts of vision loss but not total blindness) in both eyes for an additional 2.3 million people.[3] Eye injuries are the leading cause of monocular blindness (blindness in one eye). For pilots — and others — proper methods of protecting the eyes prevent many eye injuries, and proper treatment often prevents vision loss that might jeopardize a pilot's career.

Vision is a process in which the eye and the brain work together (Figure 1, page 2). For a person with normal vision, the process is as follows: When the person looks at an object, light coming from the object enters the cornea (the transparent dome on the surface of the eye). The cornea refracts (bends) the light to channel it through the pupil (the black area in the center of the eye) into the lens, which focuses the light on the retina (the eye's innermost lining). The resulting image is inverted. The retina converts the light into electrical signals, which are transmitted along the optic nerve to the brain, where the image is perceived in an upright position and interpreted. (The amount of light entering the eye is controlled by the iris [the round, colored part of the eye surrounding the pupil], which uses tiny muscles to dilate and constrict the pupil.)

Several elements of good vision are important to pilots, including the following:

- Spatial resolution includes the ability to see detail. Spatial resolution is important in virtually all pilot tasks, whether they involve distance vision (i.e., conducting takeoffs and landings and scanning for other traffic) or near vision (i.e., reading charts). This ability to see detail is called visual acuity;
- Depth perception and stereopsis are related elements in assessing distances. Depth perception is the ability to estimate the absolute distance between you and an object or the relative distance between two objects (i.e., which object is closer to you). Depth-perception cues can be monocular and/or binocular. Stereopsis is binocular perception that results from the distance between the eyes, producing a slightly different image of an object on each retina. Good stereopsis requires good visual acuity in both eyes for the distance at which a specific task is performed. Stereopsis is considered significant only within about 200 meters/650 feet; beyond that



Source: Stanley R. Mohler, M.D. and Flight Safety Foundation

Figure 1

distance, monocular cues are used for depth perception. Monocular cues are subject to visual illusions — although such illusions are less likely at a distance — and use of monocular cues for depth perception is a learned skill that can be improved with training and experience. For pilots, accurate depth perception is required for a number of tasks, including those that involve judging the distance between their aircraft and another aircraft. Stereopsis may be most important on the flight deck, where tasks involve close-quarter manipulations of flight controls and other devices;

- Visual field refers to the unaided, unobstructed ability to see the outside world. Each human eye has an instantaneous monocular visual field that is roughly oval in shape and measures approximately 120 degrees vertically by 150 degrees horizontally. Together, both eyes have a full binocular visual field of approximately 120 degrees vertically by 300 degrees horizontally.[4] Pilots typically have a full binocular visual field, except for any area blocked by the frames of eyeglasses/sunglasses. (In some types of military aircraft, however, pilots use helmet-mounted displays that also reduce the visual field.) A pilot who loses vision in one eye experiences two problems: a substantial reduction of the visual field and a blind spot at the location where the optic nerve connects to the retina. In normal binocular vision, this blind spot presents no problems. In monocular vision, however, an object would not be detected while it was within the blind spot of the remaining eye; and,

- Color discrimination involves the ability to differentiate between similar colors. For pilots, color vision is essential in recognizing aircraft position lights, light-gun signals, airport beacons, approach-slope indicators, symbols on aviation charts and information on flight-deck instruments and warning lights.

The International Civil Aviation Organization (ICAO) *Manual of Civil Aviation Medicine* says that pilot applicants for Class 1 medical certificates shall have normal fields of vision, with distant visual acuity of at least 6/9, measured metrically (20/30, according to the English system), in each eye separately,[5] "with or without the use of correcting lenses" and shall be able to read vision charts at a near distance of 30 centimeters to 50 centimeters/12 inches to 20 inches and at an intermediate distance of 100 centimeters/40 inches.[6]

"The effectiveness of each individual's visual system is of the utmost importance if flight crew and air traffic control personnel are to carry out their duties safely and efficiently," the manual says. "Visual perception is usually the first step in the reflex chain which initiates the motor activity to avoid collision."

Nevertheless, ICAO recommends flexibility in assessing pilots with visual deficiencies, and civil aviation authorities typically allow the medical certification of pilots whose vision does not meet their standards — even monocular pilots — if the pilots can satisfy specific requirements that demonstrate that their condition does not jeopardize flight safety.

Most Injuries Occur at Home, Work

Numerous studies worldwide have assessed the prevalence of and risk factors for eye injuries, including the following:

- In Australia, among 4,744 people age 40 and older, 21 percent had experienced at least one eye injury. About 19 percent of the 3,271 urban residents and 25 percent of the 1,473 rural residents had experienced an eye injury. Men had an eye-injury rate of 34 percent, compared with a rate of 10 percent among women.[7]

  Most eye injuries — 60 percent — occurred in the workplace, 24 percent occurred in the home, 11 percent occurred during sports and recreation, and 4 percent occurred during travel.

  Of those who received eye injuries during sports, none were wearing eye protection. Of those injured in the workplace, 19 percent wore eye protection (the highest level in any category) and 5 percent were hospitalized for treatment (the lowest rate of hospitalization).

  The study cited the most common causes of eye injury as steel/other metal hitting the eye (31 percent), drilling/grinding/sanding (11 percent) and welding (9 percent). Cumulative rates of eye injury were calculated according to the person-years at risk in various industries and occupations. The industries with the highest cumulative rates of eye injuries were communication, with 14 injuries per 1,000 person-years at risk, and construction, with 13 injuries per 1,000 person-years; occupations with the highest cumulative eye-injury rates were "tradespersons,"

with 18 injuries per 1,000 person-years, and managers and administrators, with 11 injuries per 1,000 person-years;

- In the United States, about 2.4 million eye injuries occur each year.[8] The U.S. Eye Injury Registry (USEIR), which since 1988 has maintained statistics on eye injuries, has recorded injuries among people ranging in age from infants to 103 years, with a mean age of 29 years. Fifty-seven percent of injuries involve people younger than 30.[9] (Similar registries have been formed in more than 30 countries throughout the world; together, they constitute the World Eye Injury Registry.)

  USEIR data show that 40 percent of reported U.S. eye injuries occur in the home — a greater percentage than occur anywhere else — and 13 percent occur in three other location categories: roads and highways, sports and industry. Some non-industrial accidents also are work-related; USEIR data show that work-related eye injuries account for 20 percent of the total, with more injuries reported among construction workers than any other occupation; and,

- The Hungarian Eye Injury Registry (HEIR), which has worked in collaboration with USEIR since the 1980s, recorded more than 1,200 eye injuries from 1989 through 1997. Fifty-seven percent of those injured were younger than 30, and about 80 percent were male.[10]

  Among injuries recorded in the HEIR database, the most frequent location category for the injury was the home, where 35 percent of injuries occurred, followed by industry, where 14 percent of injuries occurred.

Causes of Injury Include Sun Exposure, Trauma

The causes of eye injuries are diverse. The most common are radiation exposure, blunt trauma and penetrating trauma, chemical burns, foreign particles in the eyes, and corneal abrasions.

Injuries from radiation exposure most often are associated with visible light and ultraviolet radiation (UVR). Overexposure to UVR can damage the outer layer (epithelium) of the cornea, can produce cataracts and can increase the risk of macular degeneration (deterioration of the macula, the central portion of the retina that contains the greatest concentration of light-sensitive cells and processes the details in the center of the field of vision).

Common sources of UVR include the following:

- The sun emits both visible light and UVR. Staring for several minutes at the sun (or at the area around the sun during a solar eclipse) can damage the cells in the fovea (the central part of the retina) that enable the eyes to see fine details. This damage can result in a blind spot in the center of the field of vision, which can be temporary but often is permanent. When the eyes are exposed directly to the sun's UVR reflected off snow or ice, the result can be temporary blindness or partial blindness known as "snow blindness" (see "For Pilots, Sunglasses Are Essential in Vision Protection," *Human Factors & Aviation Medicine* Volume 49 (July–August 2002);

- Lasers are devices that emit intense, narrow beams of light that can deliver concentrated doses of radiation to the eye. More than 600 incidents have been reported worldwide in which aircraft flight decks were illuminated by laser-light beams from laser-light entertainment displays or laser pointers; some of these incidents have resulted in vision impairment or distraction among pilots (see "Laser-light Displays, Laser Pointers Disrupt Crewmember Vision," *Human Factors & Aviation Medicine*, Vol. 48 (November–December 2001);

- Sun lamps emit intense radiation that can burn the cornea within several minutes, even through closed eyelids and ordinary sunglasses. Anyone using a sun lamp or tanning bed also should use special goggles and should ensure that the goggles are not cracked and that they fit snugly;[11] and,

- Electric arc welding equipment, which emits UVR and infrared radiation, can cause painful burns on the retina that can be permanent and can result in vision loss. UVR can cause "arc eye," with symptoms of watery eyes, a sensitivity to light and a sensation of sand in the eyes; this condition requires rest for the eyes and, if the symptoms are accompanied by pain, medical attention. Repeated exposures can result in cataracts (the clouding of small areas of the normally transparent tissue in the eye's lens). Welders typically wear face shields with filtered glass to protect against radiation and glare from the electric arc and should wear goggles or safety glasses with side shields under the face shield to protect against loose particles that might enter the eyes. Many welding injuries involve people who are not using welding equipment but who are watching someone else use the equipment. An eye injury can occur from looking for only a few seconds at electric arc welding equipment, even from a distance of 10 feet to 16 feet (three meters to five meters). Some specialists recommend appropriate protective goggles for anyone within about 75 feet (25 meters) of electric welding arcs.[12,13] Appropriate warning signs should be posted in areas where UVR exposure is possible.

  Laser welding equipment, which has an intensely focused light, also can cause severe eye injuries or blindness to anyone whose eyes are exposed to the direct path of the laser beam.

Trauma can cause eye injury, and USEIR data show that 49 percent of eye injuries in the United States are a result of trauma. There are two general types of trauma:

- Blunt trauma occurs when the eye is struck with a solid (but not sharp) object, such as a finger, fist, elbow, club, baseball, tennis ball, etc. These injuries damage the eye as a result of the sudden compression and indentation of the eye that occurs at the moment of impact. Bleeding may occur in the front of the eye between the cornea and iris, a condition referred to as a hyphema. The normally clear lens may become clouded as a result of the impact, forming a cataract that blocks light from reaching the retina. The lens may be displaced within the eye and may become unable to focus light into a clear image.[14] Blunt trauma also can damage the retina and outer parts of the eye, including the eyelid and the surrounding eye socket bone and tissue; and,

- Penetrating trauma occurs when the eye is punctured by a sharp object, such as a knife or a piece of glass, or by a high-velocity projectile, such as a piece of metal or a BB-gun pellet. This type of injury can be the most severe and the most likely to result in permanent loss of vision, either as a result of damage from the sharp object or as a result of an infection. Surgery almost always is required to treat this type of injury. The introduction of new microsurgical techniques and the development of new antibiotics have improved the chances of saving many of these severely injured eyes and preventing vision loss.[15]

Exposure of the eyes to chemicals can result in minor — but painful — burns, as well as in damage almost as severe as that caused by penetrating trauma. Minor injuries and temporary injuries may result from brief exposures to such chemically neutral substances as hair spray and deodorant. Exposure to alkalis, acids, corrosive chemicals and organic solvents, however, typically results in severe and potentially blinding injuries. Many household products, such as drain cleaners and floor cleaners, contain alkali and should be used with caution. Exploding car batteries are the primary cause of acid burns.

Abrasions (scrapes) on the cornea are a frequent eye injury requiring medical care. Fingernails, contact lenses, paper edges and rubbing of the eyes frequently cause these abrasions. Corneal abrasions also may be caused by airborne particles that strike the eye during drilling, hammering or other tasks. These injuries can be very painful and may be accompanied by blurred vision, tearing, redness or sensitivity to light.

The most common eye injury results from a foreign particle that enters the eye and causes significant eye irritation. Even very small of particles can scratch the eye. Small flakes of metal or rust (which can leave a permanent stain on the cornea)[16] are common in work involving machines, aircraft repairs, automobile repairs and hammering nails. Foreign particles may become trapped under the upper eyelid and may scratch the cornea repeatedly as the eye blinks. Small particles also may become embedded in the cornea. In some circumstances, foreign particles that strike the eye at a high speed can penetrate the eye's surface; such an injury is most frequent during work that involves drilling, sandblasting, spraying paint, using high-speed rotating devices that may break or disintegrate or other similar activities.[17]

Contact lenses may present risks of infection or abrasions if the contact lenses fit poorly, if contact lenses are worn too long, if small particles become trapped between a contact lens and the cornea, and if the contact lenses are not kept clean.

To prevent infection, wearers of contact lenses should wash both hands — preferably with fragrance-free soap — before handling contact lenses; should comply with instructions for cleaning contact lenses; and should not allow cosmetic lotions, creams or sprays to touch contact lenses. They also should ensure that fuels and chemicals — including those used around aircraft — are not transferred from the hands to the eyes.

The risk of abrasions can be limited by wearing protective eyewear, such as wrap-around sunglasses with side shields to protect the eyes not only against sunlight but also against windblown particles that might be blown into the eyes.

Improper Use of Household Products Causes Many Injuries

Many of the causes of eye injuries are common household items. One study showed that in 1991 in the United States, nearly 300,000 consumer product-related eye injuries were treated in hospital emergency rooms. Nearly 500 different products were involved in these injuries.[18] The leading causes were contact lenses, which accounted for more than 25,000 emergency room visits, welding equipment, hair curlers and curling irons, and workshop power grinders.

Other injuries occur to individuals using lawn mowers, which can pick up rocks or debris obscured by the grass and expel them into the eyes of the person operating the mower or a bystander, and other grass-trimming/tree-trimming equipment.

Nonprofessional fireworks displays are the cause of thousands of eye injuries annually. In the United States, about 11,000 people sought treatment in hospital emergency rooms in 2001 for fireworks-related injuries; of that number, about 30 percent had eye injuries.[19] Of the fireworks-related eye injuries, about one-third resulted in permanent blindness in one eye.[20]

A seven-year analysis of USEIR data showed that the most dangerous type of fireworks is the "bottle rocket," a device whose trajectory is unpredictable and virtually uncontrollable. These devices cause approximately 70 percent of fireworks-related injuries; almost half of these injuries

result in the loss of an eye. Factors most often cited in accident reports show that the primary causes of bottle-rocket injuries are misuse, such as the intentional aiming of bottle rockets at other people, and malfunctions, such as premature explosion of the devices.

USEIR data also showed that bystanders are injured by fireworks more often than those who ignite the fireworks and that nearly half of those injured are younger than age 15.[21]

Racquet Games Cited in Sports-related Eye Injuries

Sports are a common source of eye injuries because of the popularity of games that involve balls moving at high speed (sometimes becoming uncontrollable missiles). The aggressive nature of contact sports such as basketball and football also contributes to the frequency of eye injuries. Some sports-related eye injuries involve minor corneal abrasions; others result in more serious problems, such as a loss of vision in one eye.

Worldwide, racquet sports (including racquetball, tennis, handball and others) are responsible for the greatest number of sports-related eye injuries.[22] In the United States, most sports-related eye injuries occur during baseball games; many baseball organizations have adopted vision-protection requirements. As a result, the percentage of basketball-related eye injuries is increasing relative to baseball-related injuries.

Increasingly, eye injuries are occurring during a relatively new game, paintball, in which compressed-gas guns are used to shoot semi-soft capsules containing a non-caustic, colored fluid at opponents participating in the game. One strategy is to aim the capsule — which typically is less than 0.75 inch (1.9 centimeters) in diameter and can travel as fast as 300 feet (92 meters) per second — at an opponent's eyes. The resulting injuries are examples of blunt trauma. By the end of 2000, USEIR had recorded 59 paintball injuries, many of them severe. Ninety-three percent of the injuries involved men and boys, and most occurred during casual, unsupervised play.[23]

Blurred Vision, Pain Indicate Need for Medical Treatment

Eye injuries typically are classified into two categories: those that require immediate professional medical treatment and those that may be treated using basic first aid procedures. Nevertheless, if blurred vision is present (and does not clear with blinking), if pain or other symptoms do not gradually lessen with time or if complete improvement does not occur within 24 hours, medical attention should be sought.

Following an eye injury, the following general rules almost always apply:

- Never rub the eyes. This will aggravate an injury;
- Wash hands thoroughly before touching the eyes. This will decrease the possibility of infection and further injury;
- If contact lenses are being worn, try to remove them; and,
- Do not squeeze the eye shut. This can increase pressure inside the eye, possibly worsening any internal damage.

In situations involving a foreign particle in the eye, the first step is to gently flush the eye with sterile saline solution or water. Lifting the eyelid may help dislodge the particle. If professional medical treatment is required, the treatment may involve additional irrigation of the eye, an examination using a special dye and a light source to aid in detecting the foreign particle, and the application of a mild anesthetic.[24]

If there is a superficial corneal abrasion, an antibiotic ointment may be applied for several days. If the abrasion is more serious, an eye patch may be required to hasten healing and to protect the eye from further injury.

Superficial cuts on the eyelid or the surrounding tissue typically are treated by cleaning the cuts and applying antibiotic ointment and a loose bandage.

If chemicals have burned the eyes, an eye wash should be administered for at least 15 minutes before seeking further medical treatment. Workplaces where chemicals typically are used and those where there is a high risk of chemical burns often have emergency eyewash equipment. (Such equipment is required by law in some jurisdictions.) Additional treatment may include further irrigation of the eyes and application of anesthetic eye drops, an antibiotic ointment and a sterile bandage.

Blunt trauma typically requires immediate professional medical treatment. Symptoms typically include contusions or bruises (a "black eye") that develops within 24 hours of the injury, internal bleeding and flashes of light, which indicate possible damage to the retina. Blurred vision often is present. These symptoms may be a result of damage to the inside parts of the eye.

Any penetrating injury requires an immediate visit to the nearest hospital emergency room. There is little first aid that can be provided before reaching the emergency room beyond attempting to calm the injured person. Pressure should not be applied to a ruptured eye, and the eye should not be flushed with any liquid. If possible, the eye should be protected from further injury by a large cover — such as the open end of a paper cup or plastic cup. Minor penetrations may seal themselves, but surgery may be the only recourse for many penetrating injuries.

Protective Eyewear Is Key Factor in Preventing Injury

Eye injuries are among the most avoidable types of injuries, and an estimated 90 percent can be prevented if appropriate protective eyewear is worn.[25] Prevention includes the following three basic elements:

- Learn about where eye injuries typically occur and how. People who use tools, machinery and other equipment should read the instructions for those devices — especially specific safety warnings — before using them;

- Be aware of potential eye hazards. Before a person begins a task or activity, he or she should consider potential sources of injuries (including eye injuries). He or she should consider such questions as: Am I using a substance (such as hydraulic fluid or paint) that can splash into my eyes? Will there be sharp objects or edges near my face while I do this? Is there a chance for dust or flying pieces of material to be produced?

  The person also should remember basic practices: Wash both hands after using household chemicals, keep spray nozzles directed away from the face, carefully open any bottles or cans under pressure, follow directions in handling batteries; and,

- Wear recommended protective eyewear, typically either safety glasses or safety goggles. (Regular eyeglasses and contact lenses do not adequately protect the eyes.) Safety glasses have a design similar to eyeglasses but have impact-resistant lenses that typically are manufactured from polycarbonate, a type of optical plastic that is relatively lightweight and more impact-resistant than other lens materials. Safety glasses may have side shields for added protection. They can be purchased with or without prescription lenses.

  Safety goggles typically provide better protection than safety glasses. Goggles fit completely over the eyes, are snug and have large lenses, which improve peripheral vision. They fit over most eyeglasses and often have indirect air venting to help protect against chemical splashes.

  Face shields also provide protection, although, when worn by themselves, they are not considered safety eyewear. Face shields typically are attached to a headband and can cover the entire face, extending from the forehead to below the chin. Although they can protect the face and eyes against flying debris, they should be worn with safety glasses or goggles.

Sunglasses provide another type of eye protection. They protect the eyes against the sun's UVR and against uncomfortably high light intensity that can degrade visual performance. The correct sunglasses for pilots are those that block 99 percent to 100 percent of UVR without distorting colors.

Eye injuries are associated with many types of activities and often occur in the workplace, at home and in recreational settings. These injuries can cause permanent disability — and can interrupt or can end a pilot's career. The best methods of avoiding injury involve compliance with appropriate safety practices, including the use of protective eyewear.♦

Notes

1. A "significant" eye injury, also known as ocular trauma, is one that requires treatment consisting of more than basic first aid.

2. Pizzarello, L.D. "Ocular Trauma: Time for Action." [Editorial] *Ophthalmic Epidemiology* Volume 5 (Issue 3, 1998): 115-6.

3. Negrel, A.; Thylefors, B. "The Global Impact of Eye Injuries." *Ophthalmic Epidemiology* Volume 5 (Issue 3, 1998): 143-167.

4. Zuckerman, L. *Perimetry*. Philadelphia, Pennsylvania, U.S.: Lippincott. 1954.

5. People with 6/6 vision have what is considered normal visual acuity; their eyes see clearly at six meters what normal eyes see at six meters. (The English system equivalent is 20/20 vision, which means that a person can see clearly at 20 feet what someone with normal eyes sees at 20 feet.) People with 6/9 vision (or 20/30 vision) have below-normal visual acuity; their eyes see clearly at six meters what someone with normal vision would see clearly at nine meters.

6. International Civil Aviation Organization (ICAO). *Manual of Civil Aviation Medicine 2nd Edition*. Montreal, Quebec, Canada. 1985.

7. McCarty C.A.; Fu, C.L.; Taylor, H.R. "The Epidemiology of Ocular Trauma in Australia." Presented at The Association for Research in Vision and Ophthalmology, May 1999.

8. Wong, T.Y.; Tielsch, J.M. "Epidemiology of Ocular Trauma." *Duane's Clinical Ophthalmology* Volume 5, Chapter 56. Philadelphia, Pennsylvania, U.S.: Lippincott. 1998.

9. U.S. Eye Injury Registry (USEIR). *Eye Trauma Epidemiology and Prevention*. <www.useironline.org/prevention.htm>. Jan. 15, 2003.

10. Kuhn, F.; Mester, V.; Berta, A.; Morris, R. "Epidemiology of Serious Ocular Trauma: The United States Eye Injury Registry (USEIR) and the Hungarian Eye Injury Registry (HEIR)." *Der Ophthalmology* Volume 95 (May 1998): 332-343.

11. Columbia University College of Physicians and Surgeons Complete Home Medical Guide. *Everyday Eye Care.* <http://cpmcnet.columbia.edu/texts/guide/hmg30_0002.html>. Jan. 13, 2003.

12. U.S. Consumer Product Safety Commission. *Safety Commission Warns About Eye Injuries From Welding* CPSC Document 5109. <www.cpsc.gov/cpscpub/pubs/5109.html>. Jan. 16, 2003.

13. Canada Safety Council. *Welding: Eye Protection*. <www.safety-council.org/info/OSH/welding.htm>. Jan 17, 2003.

14. Elkington, A.; Shaw, P. "Injuries to the Eye." *British Medical Journal* Volume 297 (July 16, 1988): 122–125.

15. Ibid.

16. Virtual Flight Surgeons. *Eye Protection and Optimum Vision for Pilots*. <www.aviationmedicine.com/visionoptimum.htm#intro>. Jan. 9, 2003.

17. Australian National Occupational Health and Safety Commission. *Prevention of Eye Damage*. Canberra, Australia: Australian Government Publishing Service. 1989.

18. Sastry, S.M.; Copeland, R.A. Jr.; Mezghebe, M.M., et al. "Consumer Product-related Ocular Trauma." *Journal of the National Medical Association* Volume 87 (May 1995): 349.

19. Chynn, Emil. "How Not To Get Blown Up (The Old-fashioned Way) on July Fourth." American Council on Science and Health. <healthfactsandfears.com/featured_articles/jul2002/julyfourth070302.html>. July 3, 2002.

20. USEIR.

21. Prevent Blindness America. *Fireworks Safety.* <www.preventblindness.org/safety/fireworksafety.html>. Jan. 16, 2003.

22. Pashby, Thomas J.; Vinger, Paul; Witherspoon, Douglas. "Racquet Sports Responsible for Most Sports Eye Injuries." *Ophthalmology World News*, Volume 1 (June 1995).

23. Wilson, E.D. "The Deadliest Game: Paintball Games Claim Sight," *Ophthalmology News* Volume 5 (December 2000).

24. Berkow, R. (editor) "Eye Injuries." *The Merck Manual of Medical Information — Home Edition*. Section 20, Chapter 218. Whitehouse Station, New Jersey, U.S.: Merck Research Laboratories. 1997.

25. USEIR.

About the Authors

Clarence E. Rash is a research physicist at the U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Alabama, U.S. He has 23 years of experience in Army aviation research and development and is the editor of Helmet-Mounted Display: Design Issues for Rotary-Wing Aircraft, *SPIE Press, 2000. Sharon D. Manning is an aviation safety technician at the Aviation Branch Safety Office (ABSO), Fort Rucker. She has 10 years of experience in U.S. Army aviation safety.*

Further Reading From FSF Publications

Mohler, Stanley R. "Early Diagnosis Is Key to Correcting Age-related Vision Problems Among Pilots." *Human Factors & Aviation Medicine* Volume 47 (September–October 2000).

Monaco, William A. "Contact Lenses Present Flight Crewmembers With Benefits, Unique Risks." *Human Factors & Aviation Medicine* Volume 47 (March–April 2000).

Mohler, Stanley R. "Laser Eye Surgery Gains Popularity Among Nearsighted Pilots Seeking Better Vision." *Human Factors & Aviation Medicine* Volume 46 (September–October 1999).

Mohler, Stanley R. "Vision-reducing Cataracts Can Be Counteracted Through Precautions and Surgery." *Human Factors & Aviation Medicine* Volume 46 (January–February 1999).

FSF Editorial Staff. "MD-88 Strikes Approach Light Structure in Nonfatal Accident." *Accident Prevention* Volume 54 (December 1997).

Koenig, Robert L. "FAA Tests Task-specific Eyeglass Lenses for Air Traffic Control Specialists." *Airport Operations* Volume 23 (May–June 1997).

Mohler, Stanley R. "Cockpit Crew Members Can Overcome Common Eye Problems." *Human Factors & Aviation Medicine* Volume 42 (September–October 1995).

Mohler, Stanley R. "Aviation Careers May Hinge on Vision Protection." *Human Factors & Aviation Medicine* Volume 41 (January–February 1994).

Want more information about Flight Safety Foundation?

Contact Ann Hill, director, membership and development,
by e-mail: hill@flightsafety.org or by telephone: +1 (703) 739-6700, ext. 105.

Visit our Internet site at <www.flightsafety.org>.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Human Factors & Aviation Medicine*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for material submitted. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to manuscripts and payment is made to authors upon publication. Contact the Publications Department for more information.

Human Factors & Aviation Medicine

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Rick Darby, editorial associate; Karen K. Ehrlich, web and print production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and, Patricia Setze, librarian, Jerry Lederer Aviation Safety Library

Subscriptions: One year subscription for six issues includes postage and handling: US$240. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, membership services coordinator, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708