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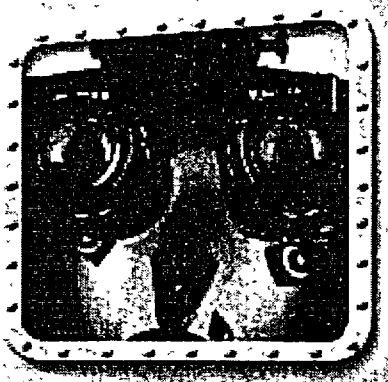

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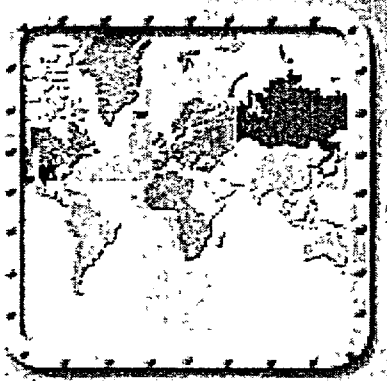

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FLIGHT Safety
MAGAZINE

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GENERAL MICHAEL E. RYAN
Chief of Staff, USAF

MAJ GEN TIMOTHY A PEPPE
Chief of Safety USAF

COL MARK K. ROLAND
Chief, Safety Education and Media Division
Editor-in-Chief
DSN 246-2968

JERRY ROOD
Managing Editor
DSN 246-0950

CMSGT MIKE BAKER
Maintenance/Technical Editor
DSN 246-0972

PATRICIA RIDEOUT
Editorial Assistant
DSN 246-1983

DAN HARMAN
Electronic Design Director
DSN 246-0932

TSGT MICHAEL FEATHERSTON
Photo Editor
DSN 246-0986

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Commercial Prefix (505) 846-XXXX
E-Mail — jerry.rood@kafb.saia.af.mil
Address Changes —
patricia.rideout@kafb.saia.af.mil

24 hour fax: DSN 246-0931
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PURPOSE — *Flying Safety* is published monthly to promote aircraft mishap prevention. Facts, testimony, and conclusions of aircraft mishaps printed herein may not be construed as incriminating under Article 31 of the Uniform Code of Military Justice. The contents of this magazine are not directive and should not be construed as instructions, technical orders, or directives unless so stated. SUBSCRIPTIONS — For sale by the Superintendent of Documents, PO Box 371954, Pittsburgh PA 15250-7954. REPRINTS — Air Force organizations may reprint articles from *Flying Safety* without further authorization. Non-Air Force organizations must advise the Managing Editor of the intended use of the material prior to reprinting. Such action will ensure complete accuracy of material amended in light of most recent developments.
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FSM notams

THE PARALLAX EFFECT

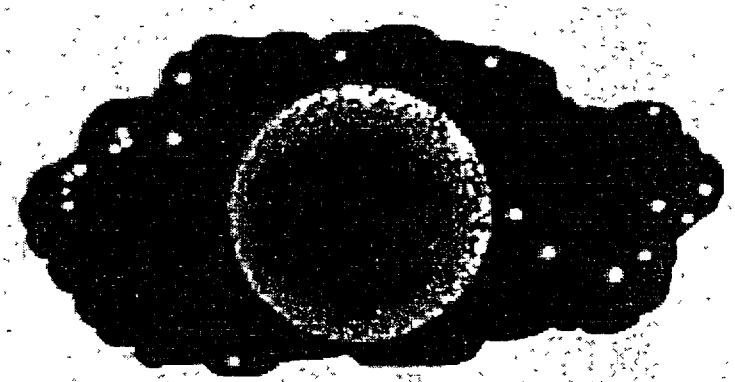
Courtesy ASRS *Callback* #246, Dec 99
NASA's Aviation Safety Reporting System

The "parallax effect" describes a type of visual illusion in which the position of an object in 3-dimensional space appears to change, due to a shift in the position of the observer. The parallax effect can make distant fixed objects, such as a planet or star, appear to be close and in motion. The twinkling planet Venus is a well-known example in aviation. Tower controllers have often cleared Venus to land, while pilots have mistaken the planet for nearby aircraft position lights.

The parallax effect is especially apt to occur during night operations when there may be few, or no, visible references to the horizon as an aircraft moves through space. Several ASRS reports illustrate, beginning with a First Officer's account of a nighttime evasive maneuver that startled crew and passengers:

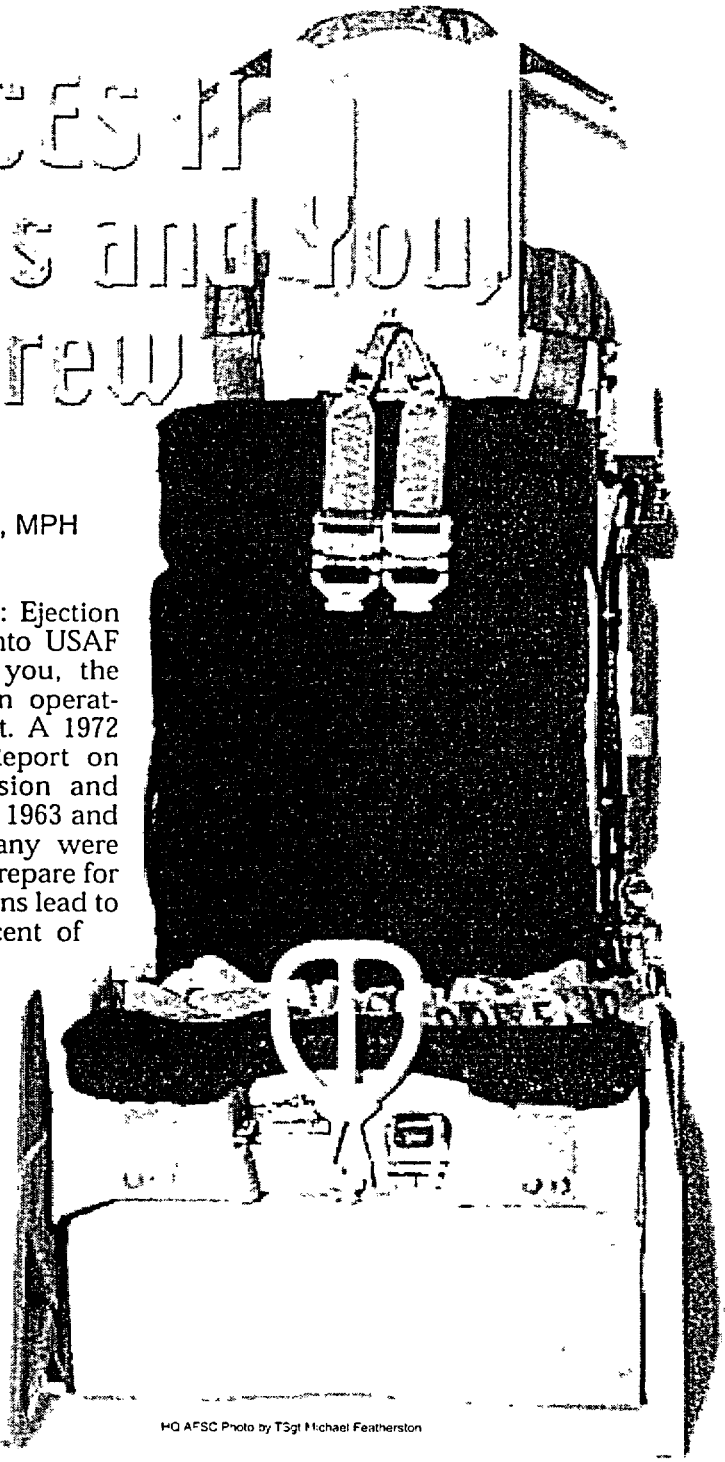
I observed what I believed to be an imminent traffic conflict. I manually overrode the autopilot and started an immediate left turn. The perceived conflict was a result of slight parallax of green and red wingtip lights of another aircraft. A bright white star also appeared as one of the running lights on the perceived conflict. The maneuver was a gut reaction on my part, as I perceived the aircraft to be within a few thousand feet from us. Passengers and flight attendants who were not seated with their belts fastened were upended in the cabin. One passenger received an abrasion to a knee and one complained of a neck injury ...After landing ...[no passengers] required medical attention ...The aircraft was inspected for overstress and no discrepancies were found.

A conservative approach, followed by the Flight Officer in this instance, is to avoid the perceived hazard first, and verify the nature of the hazard afterwards. Although this report didn't mention crew fatigue as a factor, fatigue is known to be associated with susceptibility to the parallax illusion. U.S. Air Force research has shown that a few minutes of breathing 100% oxygen will help to refocus pilots' thinking—and eyesight.



USAF ACES II Ejections and You, the Aircrew

LT COL GEORGE D'AMORE, MSME
LT COL (DR) TOM LUNA, MD, MPH
HQ AFSC/SEFL



HQ AFSC Photo by TSgt Michael Featherston

Today, the ejection seat is standard equipment in most fighter, attack, bomber and trainer aircraft.

Here's a revelation for you: Ejection systems were incorporated into USAF aircraft to save the life of you, the crewmember, especially when operating in a combat environment. A 1972 Safety Center Preliminary Report on Southeast Asia escape, evasion and recovery experiences between 1963 and 1971 provides proof (as if any were needed?) that lack of time to prepare for ejection and high-speed ejections lead to more injuries. About 44 percent of combat ejections were at high speeds, with both the number and severity of injuries higher than peacetime ejections, where the speeds at time of ejection were normally lower and injuries mostly in the minor category. At issue was high-speed ejections and what changes were needed in seat design and life support equipment to further improve crewmember survival, particularly in the combat environment. Injuries had to be minimized to give the crewmember the best chance for successful evasion and recovery. During the Vietnam War, crewmembers who ejected over unfriendly territory and suffered injuries were quite often captured.

The US Air Force continues to expand its capabilities with better-equipped, faster and higher-flying aircraft The USAF mission often puts aircrews in situations that push the envelope of survival, but great effort has been—and continues to be—exerted to reduce the chance of injuries to you and increase your odds of survival while performing the mission Today, the ejection seat is standard equipment in most fighter, attack, bomber and trainer aircraft, and it's one of the primary means for improving aircrew survival

The Advanced Concept Ejection Seat II (ACES II) ejection seat isn't the only system used today, but it is the primary

escape system used in Air Force aircraft. Effectiveness of the ACES II seat is noteworthy and crewmembers continue, with confidence and without hesitation, to use the system in time of need.

Methods

A Safety Investigation Board (SIB), which is convened at the time of a Class A flight mishap, thoroughly researches the event. Except under unusual circumstances, the SIB is required to provide a complete report of the mishap to the MAJCOM commander within 30 days. Every mishap is researched, analyzed, studied and reported with recommendations for corrective actions to prevent similar situations from resulting in mishaps in the future. SIB-collected mishap data for all USAF Class A mishaps is stored for future reference and analytical studies in a data file library located at the AF Safety Center (AFSC), Kirtland AFB, NM.

The mishap data from August 1978 to September 2000 was queried from the AF Safety Center Life Sciences and Flight Database for Class A mishaps involving aircraft with the ACES II ejection system. *(A Class A Mishap is defined as one where there is loss of life, injury resulting in permanent total disability, destruction of an AF aircraft and/or property damage/loss exceeding $1 million Ed.)* That data was used to describe ejection attempts by aircraft type. Fatal ejection attempts were defined as those where crewmembers were fatally injured after: (1) They ejected out of the envelope of the seat; or (2) An ejection malfunction occurred. The database was also queried for the total lifetime, non-combat, fatality rates for each aircraft and whether an ejection did, or did not, take place. The data for the A-10 and F-15 aircraft include the early ESCAPAC (Escape Pack) ejection system, which was used in 6 and 14 ejections, respectively. Injury data was tabulated from the first 288 ACES II mishaps involving ejections between FY78 and FY95. (See Figure 7.) Finally, all Class A mishaps, from FY96 through FY99, were comprehensively analyzed for aircrew ejection attempt errors.

Results

During an ejection, the limits of performance of humans and their equipment can be approached; those failures are closely studied. The overall ACES II ejection survival rate from Aug 1978 to Sep 2000 was 92 percent (see Table 1).

ACES II Ejection Rates
08 August 1978 - 30 September 2000

Aircraft	Survived		Fatal	
	Number	Rate	Number	Rate
A-10	37	84%	07	16%
F-15	57	91%	05	9%
F-16	222	93%	16	7%
B-1B	15	94%	01	6%
F-117	02	100%	00	0%
Total	333	92%	29	8%

Table 1

During this period, a total of 362 ejections occurred in five different types of ACES II seat-equipped aircraft. Accompanying figures depict A-10 Thunderbolt II, F-15 Eagle and F-16 Fighting Falcon lifetime ejection history totals, as well as fatalities where ejections were, and were not, attempted. Success rates are different for each aircraft, primarily because of the different mission profiles flown in those aircraft. Aircraft with specific mission profiles that have them flying faster and closer to the ground will likely have more mishaps

The A-10 has had 50 total lifetime ejections with a survival rate of 82 percent (41 crewmembers). The ESCAPAC system, an ACES II predecessor, was used in six of the total ejection attempts. Of 46 fatalities occurring in the A-10, there

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During an ejection, the limits of performance of humans and their equipment can be approached.

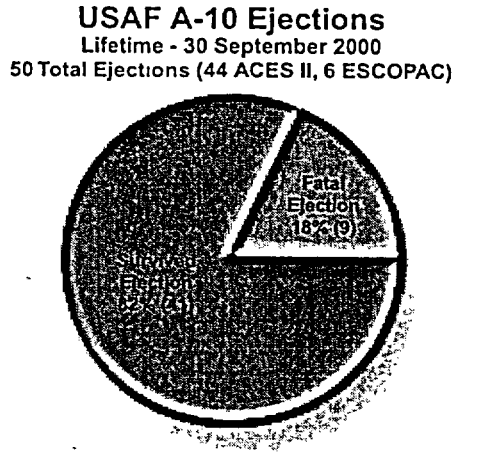

Figure 1

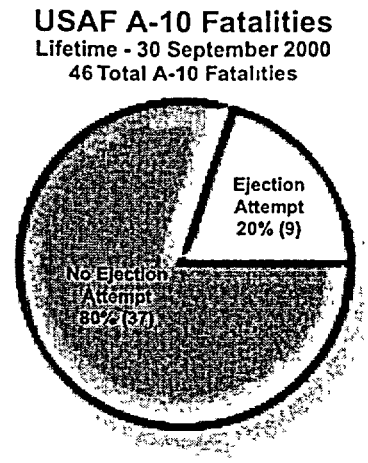

Figure 2

The F-16 has had 238 lifetime ejections in the USAF. The ejection survival rate is 93.2 percent.

were 9 ejection attempts and 37 "no attempts." See Figures 1 and 2.

The F-15 has had 76 lifetime peacetime ejections, of which 14 were with the ESCAPAC system. A total of 66 crewmembers (86.8 percent) successfully ejected. The F-15 community has experienced a total of 42 fatalities, with 32 crewmembers (76 percent) perishing with no ejection attempt. See Figures 3 and 4.

The F-16 has always used the ACES II system and has had 238 lifetime ejections in the USAF. The ejection survival rate is 93.2 percent (222 crewmembers). A total of 71 crewmembers were fatally injured in the history of USAF F-16 peacetime operations, of which 55 crewmembers (77 percent) made no attempt to eject and perished. See Figures 5 and 6.

Figure 7 quantifies the various degrees of injury resulting from the 288 peacetime ACES II ejections that occurred from FY78 through FY95. Approximately 67 percent (193 crewmembers) received either no injury or only minor injuries. About 18 percent (53 crewmembers) received moderate injuries but remained mobile. "Mobile" simply means that, in the context of a combat environment, the crewmember would be able to move and evade capture, at least to a limited extent. Approximately 15 percent (42 crewmembers) received major injuries (those

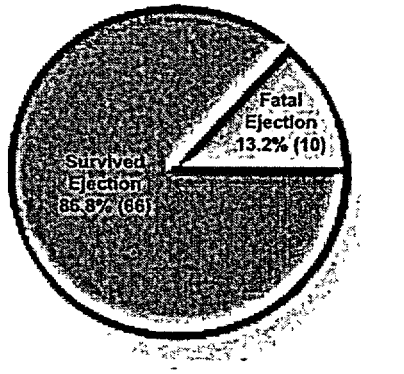

Figure 3

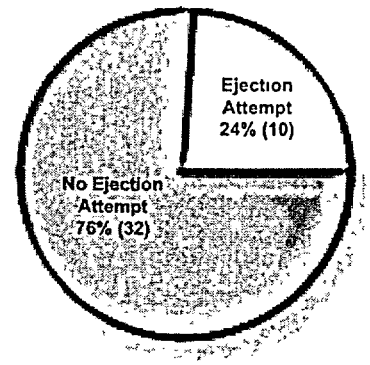

Figure 4

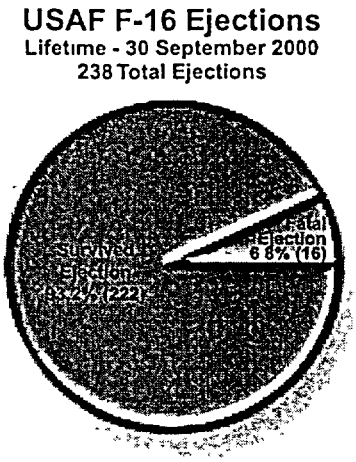

Figure 5

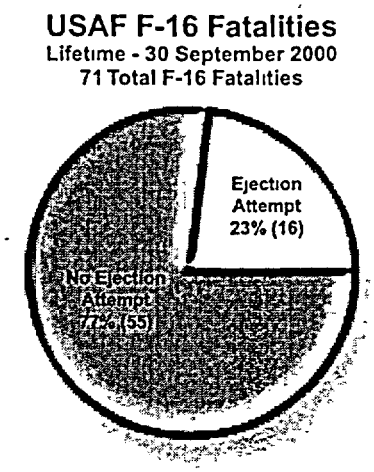

Figure 6

which were life-threatening, or loss of eyesight or a limb), were immobilized (incapable of moving from one place to another) or suffered fatal injuries.

We also took a "snapshot" of ejection errors aircrews made over a discrete period of time, FY96 through FY99. The results were telling. See Table 2. Approximately 38 percent of the aircrews didn't wear proper clothing for the mission and environment (not wearing cold weather-issue gear during a winter sortie, wearing flammable clothing, etc.). Twenty-six percent weren't prepared for the ejection (didn't attain proper body position for ejection, didn't secure loose items which could cause injury due to ejection windblast, etc.). And when the ejection decision was made, 25 percent ejected below 2000 feet, the minimum published altitude for a safe, controlled ACES II ejection altitude. Fourteen percent lost their flight helmets (helmet was secured improperly). Once aircrew members were descending to the ground under a parachute, 19 percent didn't deploy the four-line release, nine percent didn't deploy the seat kit and 15 percent didn't execute a proper PLF (parachute landing fall). Finally, take note of this one: Approximately eight percent of aircrew members forgot how to use a piece of life support equipment that was introduced in flight training

Your ability to properly use *your* life support equipment plays a huge part in the degree of ejection success. Ejection-related injuries most often result from not following ejection procedures or improperly using life support equipment. Wearing the parachute harness improperly, not securing loose-fitting equipment to survive the windblast that accompanies all ejections, not detaching a night vision device from the helmet or not deploying the parachute four-line control to minimize parachute landing injuries all have an impact on whether you do—or don't—suffer an injury during ejection.

Discussion

Aircrew members train for all possible scenarios, and emergency procedures are an integral part of that training.

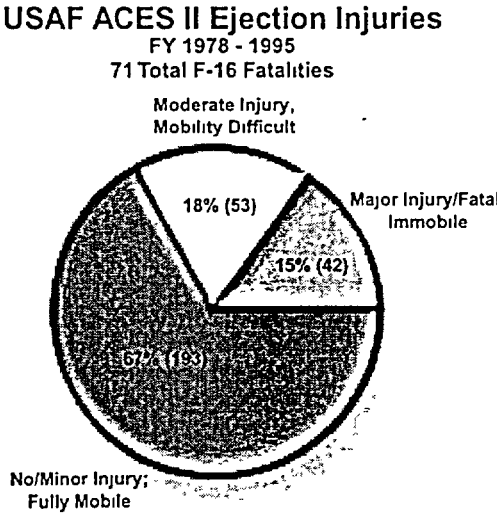

Figure 7

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Approximately 8% of aircrew members forgot how to use a piece of life support equipment that was introduced in flight training.

Aircrew Ejection Errors FY 1996 - 1999		
Number	Rate	Error
29	38%	Not wear proper clothing
20	26%	Not prepare for ejection
19	25%	Ejected below safe altitude
11	14%	Lost helmets
22	19%	Not perform 4-line release
07	9%	Not deploy seat kit
15	19%	Not perform proper PLF
06	8%	Not know piece of equipment

Total is > 100% because some crew-members commited more than a single error.

Table 2

The data reflects that checklists aren't completed and important items aren't done.

When an emergency situation occurs, if you react as you've been trained, the result should be reduced injuries. Interestingly enough however, the data shows errors committed by aircrew are typically similar from year to year. It is not presumptuous to expect these errors to lead to injuries.

One common error is not fully preparing for ejection. Crewmembers generally try to complete the pre-ejection checklist but, invariably, the data reflects that checklists *aren't* completed and important items—storing loose equipment, tightening personal equipment, and the like—aren't done. Initial windblast can easily lead to serious injuries of the arms and legs (due to flailing), as well as head and face (as when the oxygen mask isn't attached). Leg and arm restraints weren't incorporated into the ACES II system for the A-10, F-15 and F-16, so it does pose a flail problem in those airframes. But both the B-1 and the F-22 Raptor have arm and leg restraints

Once the actual ejection phase is complete and you are safely hanging in the chute, you still have to prepare for the parachute landing. Again, data indicates crewmembers don't always complete the preparation-for-landing checklist. Forgetting to deploy the four-line release is especially significant. Omitting this step means you won't be able to adjust for wind and control the parachute descent into a safe area. Based on an unofficial records review in 1989, for mishaps occurring from FY76 to FY89, the AF Safety Center calculated the injury rate was about 21 percent *higher* for aircrew members who didn't deploy the parachute four-line release. Also, some aircrew members have omitted releasing the extra survival baggage that accompanies them in the seat kit. This extra weight, if not released, can cause severe back injuries. Consequently, it's not uncommon for injuries to occur upon landing when the PLF is less than ideal due to preparation omissions.

Conclusion

The USAF's ACES II ejection seat has repeatedly proven itself to be very effective in over 20 years of operational use. Still, the Air Force isn't resting on its laurels. It is constantly improving life support equipment to endure the harsh environment of the mission so it will perform as advertised 100 percent of the time and minimize injury to you, the aircrew. Injuries are quite costly, particularly in a combat environment where evasion is a priority.

Want to significantly improve the odds you'll return uninjured from your next mission? Know when it's time to get out. Wear your gear securely and properly. Follow the pre-ejection and parachute landing checklists. Understand and practice what you've been trained. You do your part and the ACES II will do its part. Fly Safe!

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