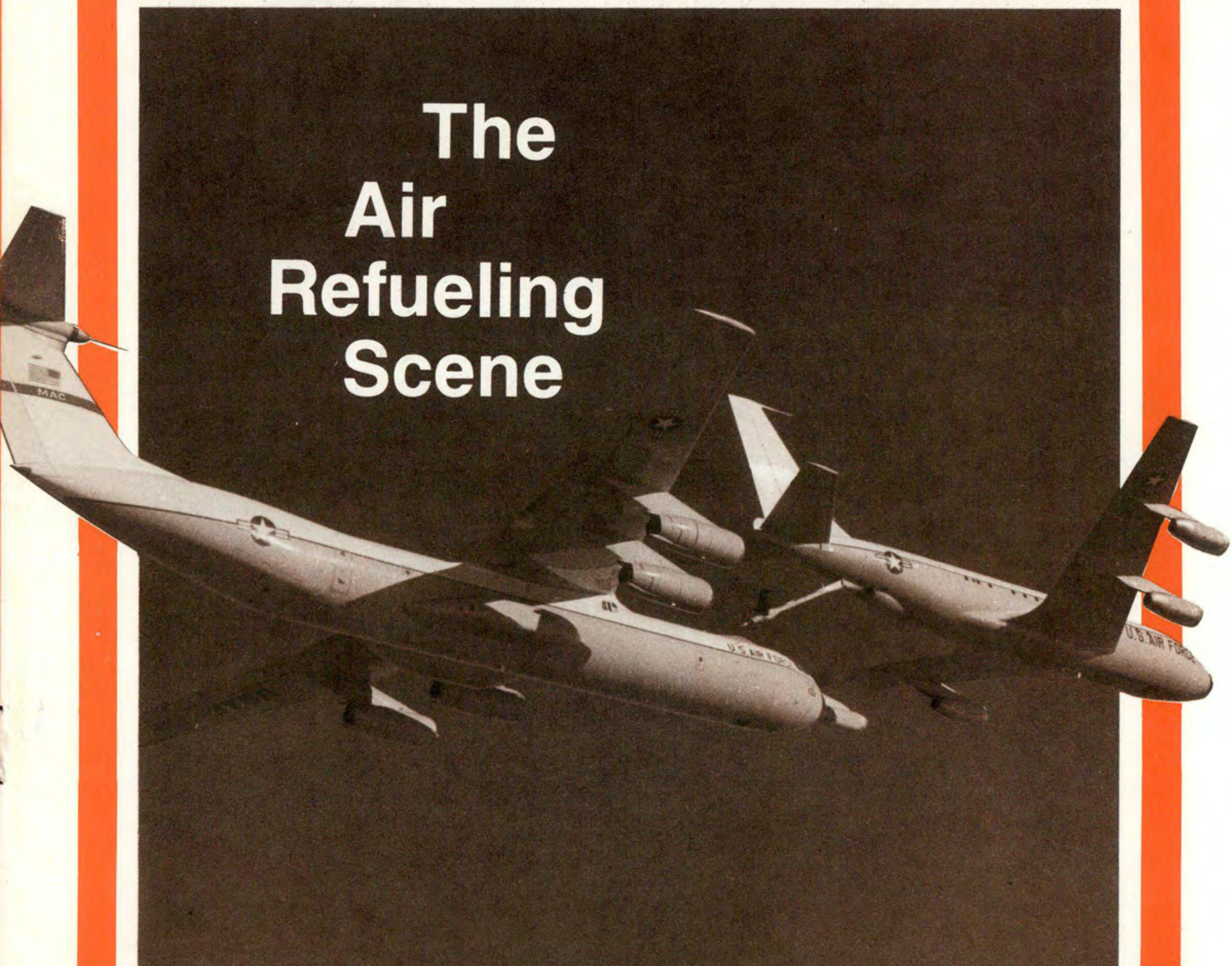
flying SAFETY

JUNE 1986

The Air Refueling Scene



THERE I WAS

■ "Why don't you lead this one?" I said to my wingman as we met in Base Ops at Torrejon to plan the next leg of our weekend cross-country into Aviano. My wingman was a 500-hour, F-4 pilot who was doing well, and we'd just entered him into flight lead upgrade training. This would be a good sortie to start with — not too challenging — just get two F-4s from Torrejon to Aviano.

The flight went well, and we'd planned to do a formation wing landing at Aviano. As an instructor, I could fill one of his flight lead upgrade squares. We had a good victor mike the whole way until we began our descent into the haze and murk of the Po Valley. There was no ceiling but the visibility was 2 or 3 miles, and the budding flight lead made a good decision to call for a precision approach.

My flight lead led a smooth approach although a little faster than I would have led it. Trying to be the alert IP, I flew a little wider on final than I would normally have flown so I could keep an eye on the lineup and his aimpoint. No landing in the overrun for me! On short final, I concentrated hard on holding a steady position on his right wing.

We had a good touchdown about 1,000 feet down the runway. As I lowered the nosewheel to the runway, I looked forward to begin my own rollout when I saw my F-4 was about 40 feet away from rolling the right main gear over the BAK-9 housing on the right side of the runway. Instinctively, I slammed the stick to the left, and fortunately, my wingman had landed us with enough extra knots to make the right aileron effective. The right gear hopped over the barrier berm without a bump.

"Doboy 11, you having any problems?" the tower asked, knowing that something had happened but not sure what.

"Negative," I croaked.

The rest of the rollout, marshaling, and parking was uneventful, and my careful inspection of the right gear and tire revealed nothing. That evening over pasta, we discussed how large a ball of tin foil we could have become if that right main had sheared off in the barrier.

A mishap board probably would have determined that I was wider than recommended, and my lead landed close to the centerline of the runway, putting me on the right edge of the runway. Fortunately, we were able to eat pasta rather than the big schnitzel. As an instructor, I thought I was flying a prudent approach under the circumstances. What did I learn from that? When you think you're doing "good," you can be 10 seconds from dying! Be careful out there. ■

UNITED STATES AIR FORCE **flying** SAFETY MAGAZINE

AIR FORCE RECURRING PUBLICATION 127-2 | JUNE 1986 | VOLUME 42, NUMBER 6

AFRP 127-2
Entered as a publication at the Second-Class rate (USPS No. 586-410) at San Bernardino Postal Service, 1331 South E Street, San Bernardino, CA 92403 and additional entries.

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REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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MICROWAVE LANDING SYSTEMS

MAJOR MICHAEL KAYE
Directorate of Aerospace Safety

■ Shortly after man learned to fly, it became obvious that if he intended to broaden his horizons by expanding aviation's operational capabilities, some form of external approach and landing guidance system would be necessary during periods of low ceilings and/or visibilities. By 1928, several countries were experimenting with different types of landing systems to fill this critical void. What evolved from these efforts was the Instrument Landing System (ILS) which is currently the international standard.

ILS Limitations

The ILS was adopted by the International Civil Aviation Organization (ICAO) in 1949 as the standard approach and landing system and has served both the national and international aviation communities extremely well through the years. Today, the US has approximately 750 ILS systems in service. However, despite improvements, the ILS still suffers from several inherent limitations that severely restrict its ability to meet present and forecast requirements.

ILS is sensitive to interference and distortions. Signal interference is primarily due to reflected signals from terrain, buildings, tides, and certain weather effects. As a result, both course and glidepath accuracy may be seriously degraded.

There are only 40 ILS frequencies available. This restriction limits the number of systems that can be installed within a specified area. As a result, several areas of the country have experienced a serious frequency congestion problem where additional ILSs cannot be installed because of intrasystem interference.

ILS is expensive to install. Costly modifications are often necessary due to extensive excavation, grading, and site preparation needed for the localizer and glidepath antennas.

ILS antennas are large. The UHF glide slope antenna is approximately 30 feet tall, and the UHF localizer antenna is often 80 feet wide.

ILS lacks operational flexibility. It is limited by a narrow glide slope and localizer beam width which provides for a single rigid straight-line final approach course extending for 5 to 7 miles from the runway threshold. Also, because of the system's size, weight, and extensive installation requirements, it has not been able to provide the military with the tactical flexibility necessary for many DOD operations.

ILS is expensive to operate and maintain. The ILS is based on 1940s technology when vacuum tubes were state-of-the-art components. These units require high power, get less reliable with age, and some of the parts are no longer produced.

The Origin of the Microwave Landing System

In the early 1960s, it became clear the ILS lacked the capabilities civilian aviation growth and military tactical operations would demand. Extensive research and development programs were begun by several agencies, and by the mid-1960s, over 50 different systems, most of which used microwave technology, had been developed.

In 1975, the FAA selected the time reference scanning beam technique (TRSB), which later became known as the Microwave Landing System

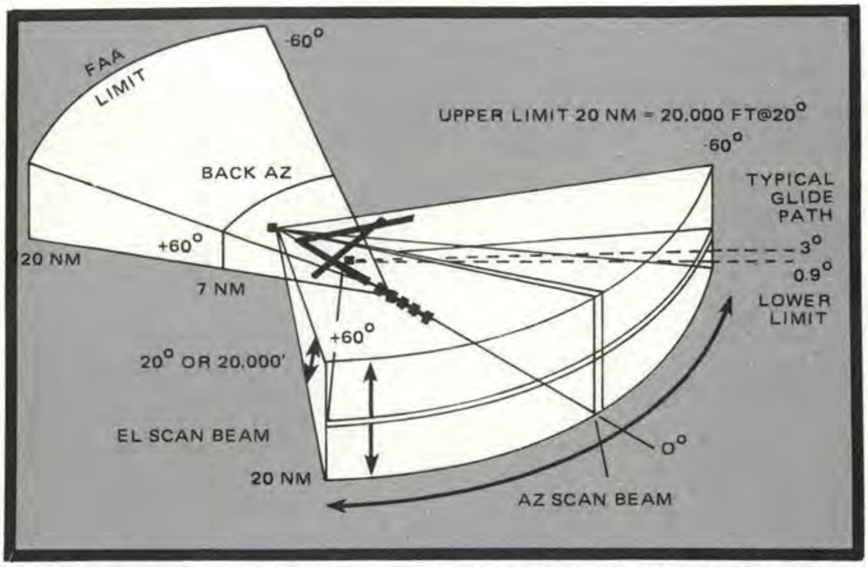

Figure 1. The MLS can provide course guidance up to 60 degrees either side of the runway centerline out to a distance of 20 miles. The pilot can select any glidepath angle from 0.9 to 19.9 degrees.

(MLS), as the superior method. In early 1978, following extensive evaluations and operational demonstrations, the ICAO sanctioned the MLS TRSB technique, developed by the US and Australia, as the standard for future international landing systems.

The MLS Ground System

MLS ground equipment consists of three primary elements — an approach azimuth station, an elevation station, and precision distance measuring equipment. The MLS operates on any one of 200 C-band channels within the 5031 MHz to 5091 MHz range.

The approach azimuth station provides lateral or course guidance and transmits information associated with the operation of the system as well as the reliability status of the ground equipment. The station transmits a horizontal fan-shaped beam with a normal beam width of 2 degrees. However, in some applications, it may be necessary to use a one-degree beam width to provide more accurate course guidance on extremely long runways or to reduce multipath problems in areas where reflective objects would otherwise result in course distortion. Narrow beam widths are only used when necessary because they require a wider antenna aperture, and this increases the cost of the antenna considerably.

As Figure 1 shows, azimuth coverage can be as little as +10 degrees or as much as +60 degrees offset from the runway centerline and has a usable range of 20 nautical miles (NM). An example of the usefulness of this feature is evident in Valdez, Alaska, where a Bendix MLS has been in operation since November 1982. In this case, azimuth coverage extends 40 degrees to the south of the runway centerline but only 10 degrees to the north to avoid multipath problems from nearby mountains.

Compare this ILS glide slope antenna and equipment shelter with the MLS elevation antenna on the previous page. The MLS is more compact, more reliable, and more versatile.

The approach elevation station provides elevation or glidepath guidance to the runway touchdown zone. Elevation data is transmitted on the same C-band frequency as the azimuth station. The elevation station also transmits a fan-shaped beam, but in this case, it sweeps vertically. Normally, the elevation beam width is 1.5 degrees but, just like the azimuth station, a one-degree beam width is used to solve multipath problems at locations where the antenna is looking into rising or irregular terrain.

The elevation station provides pilot selectable glidepaths from 0.9 degrees to 15 degrees and greater within the azimuth area of coverage. Figure 1 shows a cross-sectional view of MLS elevation signal coverage.

The precision distance measuring equipment (DME/P) provides continuous range information (+40 feet) throughout the approach. It is composed of a beacon transponder which operates in the L-band from a frequency of 962 to 1105 MHz. Although not presently the case, the DME/P frequency will be paired with the azimuth and elevation frequency so the pilot will only have to make one channel selection to receive course, glide slope, and DME/P information. Effectively, inclusion of DME/P eliminates the requirement for outer and middle markers used with the ILS.

A back azimuth station may be installed, and it is physically identical to the front azimuth station. It provides departure and missed approach guidance or precision approaches to the opposite end of the same runway. However, a bidirectional approach capability will require separate elevation and DME/P stations, and only one system can be active at a time. Also, the back azimuth station and approach azimuth station can switch functions when the runway direction is reversed.

Although the ICAO only requires a 7 NM range for a back azimuth coverage, our FAA requires a 20 NM range to provide bidirectional approaches. Figure 1 shows a view of the coverage for a bidirectional installation.

continued

Table 1 lists the six antenna option combinations specified in the current FAA procurement contract and shows the typical applications for each option.

Table 1. MLS Antenna Options

Azimuth Guidance			Elevation Guidance		Typical Application	
Type	Beam Width	Scan Angle	Beam Width	Scan Angle	Runway (feet)	Environment
I	2	+40	1.5	0.9 to 15	8-9,000	Level terrain
II	2	+40	1	0.9 to 15	8-9,000	Rising/irregular terrain
III	1	+40	1.5	0.9 to 15	14-15,000	Level terrain
IV	1	+40	1	0.9 to 15	14-15,000	Rising/irregular terrain
V	1	+10	1	0.9 to 15	14-15,000	Large reflecting objects
VI	1	+60	1	0.9 to 15	14-15,000	Rising/irregular terrain, noise abatement

Siting Considerations

Although generally more flexible than an ILS, siting is still critical in certain respects. The ground system is designed as a self-contained modular unit that can be picked up and moved. The azimuth element weighs approximately 1,800 pounds and the elevation element about 1,500 pounds. No protective shelter is required other than the weatherproof equipment cabinets. By design, the ground equipment is relatively portable which makes the physical installation of the system fairly simple.

When an MLS is installed, there are several important considerations that need to be evaluated to determine the ideal location for the equipment.

The Azimuth Station. The best location for the azimuth station is in a position along the extended centerline of the runway between 500 and 2,000 feet from the departure end. If this is not possible, alternate sites can be used, but the penalty will be a higher decision height and/or a lack of coincidence between the MLS and ILS final approach courses.

The Elevation Station. The elevation station needs to be located longitudinally at a point where a threshold crossing height of 50 feet can be obtained for the minimum selected glidepath. The distance of lateral offset can be between 250 and 600 feet, but it is best to keep the distance as short as possible. This is because, as the station's offset distance from the runway increases, the final approach path becomes less of a radial path and more of a hyperbolic path that flares above the theoretical pilot-selectable glidepath. An additional problem with excessive lateral offset is that the aircraft tends to reach the end of elevation coverage before it passes the elevation station. For both of these reasons, the elevation station should be located as close as possible to the runway consistent with obstruction clearance criteria.

DME/P. The DME/P is normally located at the azimuth station; but this is not absolutely necessary. In some instances, it may be necessary to co-locate it at the elevation station or even by itself where multipath, shadowing, or other factors would cause excessive interference with the transmitted signals.

Shadowing. This is a condition where transmitted signals are blocked by an object and is a main concern in locating MLS equipment. Shadowing can be caused by parked or moving aircraft, buildings, or any obstacle that blocks the signal. Generally, this should not create a major problem for straight-in approaches, but the critical areas of the MLS become much larger when extended coverage is used for segmented or curved approaches as shown in Figure 2.

A method to compensate for this problem is to design approaches to avoid operations in critical areas or to locate the station where the shadows are not in an important segment of the area coverage. Also, it will normally be necessary to locate

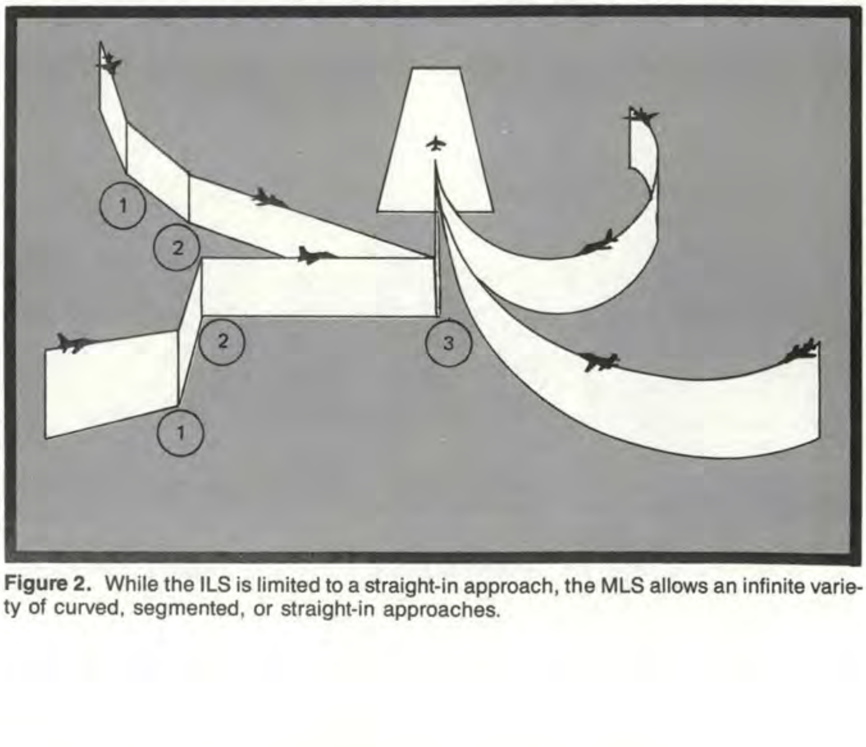

Figure 2. While the ILS is limited to a straight-in approach, the MLS allows an infinite variety of curved, segmented, or straight-in approaches.

This is the Bendix MLS azimuth station at Shemya AFB, Alaska, during its FAA comr ing flight check. This particular antenna uses a 2-degree beam width.
Photo courtesy of Allied Bendix Aerospace

the elevation station on the opposite side of the runway from the entry taxiway to limit the effects of elevation beam shadowing by aircraft holding short of the runway waiting for departure.

Multipath. Although MLS is less sensitive to multipath problems than ILS, it needs to be considered. Figure 3 shows multipath areas associated with a vertical surface, but nonvertical surfaces, such as hills or large sloping roofs, can cause problems where elevation guidance signals are concerned. The two principal methods of dealing with this situation are selecting an antenna with a narrow beam width and/or aligning the antenna scan angle to avoid illuminating reflecting surfaces that could cause problems.

The Advantages of the MLS

The system, as it is being developed today, meets or exceeds all ICAO operational requirements and is designed to provide our terminal airspace with a common civil/military system that can be used well beyond the year 2000. The MLS has been designed to overcome most of the problems associated with the ILS while at the same time providing improved performance and reliability. The major advantages are:

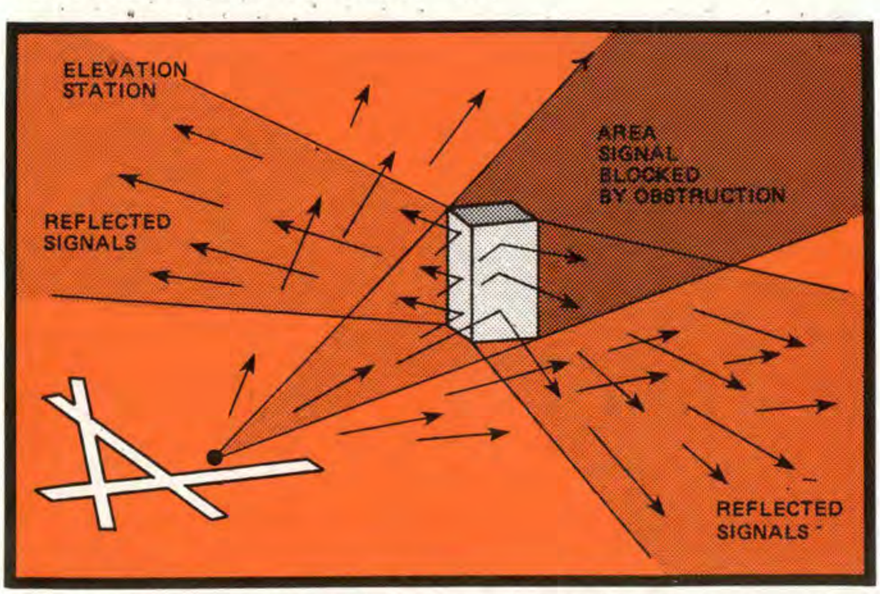

Figure 3. Although not as critical for the MLS as for the ILS, obstructions can create problems. Aircraft trying to fly the approach could receive erroneous guidance from reflected signals or lose guidance where the signals were blocked. Preinstallation planning can resolve these problems.

Cost Benefits. One of the FAA's goals, as outlined in the National Airspace System Plan (NASP), is to reduce the cost associated with the operation of our airspace system. There are two primary reasons why the MLS will be cost-effective over the long term. First, it physically requires less equipment and ground space to locate the equipment. The azimuth and elevation stations are sealed, self-contained units with attached antenna assemblies and mounting bases that do not require support structures or equipment shelters. The only things required, other than the equipment, are two standard concrete pads and electrical power. This keeps installation costs quite low.

The second factor involves the cost benefits associated with solid-state circuitry. All MLS circuits will be solid state which cost considerably less to purchase, operate, and maintain than earlier vacuum tube circuits. Because of its newer design and remote monitoring capability, MLS maintenance costs can be 60-80 percent less than those for a typical ILS.

Reliability. As mentioned previously, solid-state electronic circuits are reliable, efficient circuits. Their advantages are so pronounced the FAA has elected to convert all remaining ILSs using vacuum tubes to solid state even though many will be decommissioned in the next 10-15 years. Hazeltine is claiming a 22,500 hour mean time between failures (MTBF) for their Series 2700 MLS which provides a 90-percent confidence of failure-free operation over a 3-month period. The Valdez, Alaska, MLS (produced by Bendix) has been in operation since 1982 with only one minor failure to date.

The system is not significantly affected by environmental alterations such as moist soil, snow cover, or tides and deals well with most multipath problems. Some difficulty can be encountered with shadowing since microwave is line-of-sight, but this can usually be overcome with the flexible siting options available.

One of the major features that enhances MLS reliability is system

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The MLS is capable of operating in mountainous terrain where ILS couldn't be used. It is also more reliable under adverse weather conditions. This MLS elevation station is located in Valdez, Alaska. Photo courtesy of Allied Bendix Aerospace.

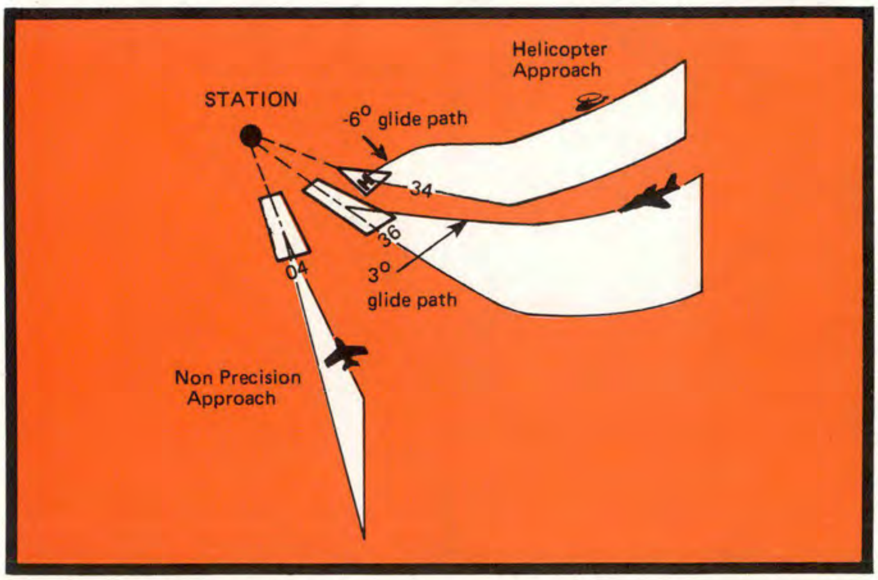


Figure 4. The MLS capabilities far exceed those of the ILS. Pilots can tailor the glidepath to the particular performance characteristics of their aircraft such as helicopters and STOL airplanes. They can also use many different approach paths to meet operational requirements.

monitoring which takes two forms — an executive monitor and a maintenance monitor. The executive monitor includes an integrity monitor and a field monitor which checks the accuracy of the angle code throughout its coverage, signal alignment, and anomalies due to environmental effects, blockage, or damage. If an out-of-tolerance condition is detected, the executive monitor automatically shuts down the station and initiates an alarm.

Each station element has a remote maintenance subsystem which periodically initiates a self-test and generates an alarm if it detects any parameter out of limits. The alarm is routed to a maintenance monitor console (MMC), often located in an Air Route Traffic Control Center or Sector Maintenance Office, which has a display status of all monitored facilities. Using the MMC, a technician can troubleshoot the system to determine which module has failed and then transport the replacement module to the site to correct the problem.

Capability. The MLS is an extremely capable approach and landing system that offers a broad range of features to enhance and streamline the arrival and departure segments of a flight. Some of these features have been discussed previously in this article but are included below to provide a complete list of all the significant capabilities.

- MLS provides multiple flight and glidepaths in a broad area around an airfield with pilot selectable approach paths available anywhere within the area of coverage. This allows an almost infinite choice of approach/departure options which can be used to control noise pollution and increase airport capacity. (See Figure 4.)

- Several aircraft can fly approaches at the same time using different paths. A study completed by the FAA indicated an installed MLS could increase the capacity of an airport by 15 percent. Although this will not totally solve the problem of

Locations that once were unsuitable for a precision approach can now have one thanks to MLS. A good example, is this Hazeltine Model 2500 located at the Wall Street, New York City Heliport. Photo courtesy of Hazeltine Corporation.

saturation at most major airports, it will help. Also, short takeoff and landing (STOL) procedures have been developed using glide slope angles in excess of 6 degrees to take advantage of the steeper-than-normal climb-out and approach capabilities of STOL aircraft.

■ There are 200 different channels available which will effectively eliminate frequency congestion and allow more MLSs to operate in a given geographic area.

■ The system is less affected by multipath and environmental change problems, and this allows it to be installed in areas where no precision approach capability was previously available. This feature has distinct advantages where mountain airports, aircraft carrier, and especially, heliports are concerned.

■ The MLS is very accurate. The ICAO's recommended accuracy values, measured in terms of path-following error and control motion noise, are presented in Table 2. Existing systems have demonstrated significantly better accuracy values than those recommended by the ICAO.

■ As the system has evolved, the components have become more compact and lighter in weight. This has allowed the development of a tactical military system with tremendous capability, especially where mobility is a factor. Presently, both the Air Force and Army are developing 252 tactical MLS units for production in the 1988-1992 timeframe. The design goal is for self-contained systems with a maximum weight of 500 pounds which are transportable on a single C-130 aircraft pallet, erectable by 2 persons in 30 minutes, and capable of 8 hours of operation on a single battery charge.

■ The MLS ground facility can transmit clearance guidance signals outside the proportional azimuth coverage area. This provides hard-right or hard-left command indications to the pilot to show when the aircraft is within range of the MLS station and direct it into an area of proportional coverage. In addition, proportional coverage is assured to twice fullscale limits which allows an early signal capture by automatic flight control systems.

■ Auxiliary data can be transmitted by the MLS ground station during normal guidance transmissions and presented to the crew on special cockpit displays. This information can include, but is not limited to, runway condition, runway length, runway visual range, ceiling, altimeter setting, wind, wake vortex, and wind shear information.

Table 2. Recommended ICAO Accuracy Values

2,000 Meter Runway 7,000 Feet	Recommended Azimuth Accuracy	Recommended Elevation Accuracy
Runway threshold Path-following error	+6 meters/+19.7 ft (+2 meters/6.2 ft)	+0.6 meter/2.0 ft (+0.1 meter/0.3 ft)
Runway threshold Control motion noise	+3.2 meters/10.5 ft (+1.2 meters/3.8 ft)	+0.3 meter/1 ft (+0.07 meter/0.2 ft)

Figures in parentheses are typical existing accuracy values.

The Disadvantages of MLS

Although the advantages of the MLS far outnumber the disadvantages, there are areas that present problems. The majority of these issues are not unique to the MLS and would exist regardless of what specific system was chosen. The main disadvantages at this point of development are:

■ In spite of an overall positive benefit to cost ratio, cost is still a principal concern. Initial startup funds have been procured, but the FAA has proposed an ambitious plan of installing 1,250 units at a rate of 100 to 150 per year that could easily encounter administrative and budgetary difficulties. Additionally, many general aviation (GA) operators are opposed to an MLS transition because of the cost of additional avionics. It is easy to understand why an owner of a $25,000 aircraft would oppose an additional $10,000 charge for MLS avionics when the ILS is more than adequate for the GA pilot's needs.

■ The proposed transition plan states no ILS will be decommissioned until all the network's ILS-equipped airports have had an MLS installed and a minimum of 60 percent of the aircraft that routinely use the airfield are equipped with MLS. When this occurs, it will have a direct effect on the remaining 40 percent of the aircraft that use the airport because they could lose their precision approach capability to the field even though they would still be equipped with a functional ILS.

■ The MLS does not solve the airport capacity problems that some people thought it would. The use of variable glide slopes and courses allows approximately a 15 percent capacity improvement. This provides some relief but is no panacea

continued

for severe airfield congestion. Also, where similar aircraft are involved, the MLS approach procedures provide approximately the same capacity as current ILS procedures.

■ The final major issue is that technology may have passed MLS by, and rapidly advancing navigational systems, such as the Global Positioning System (GPS), have already made the MLS obsolete. This may be true to a degree, but in today's environment, almost all new developments are rapidly outmoded. The most that can be expected is to select the best system for an application given available expertise at the time.

MLS Implementation

The FAA presently plans to install 1,250 MLS ground systems nationally over the next 15 years, about twice the number of ILSs now in operation. The implementation plan defines a three-phased program with specific milestones. Phase 1, which is presently underway, involves establishing 10 to 30 systems to demonstrate the benefits of MLS, refine its unique siting parameters, determine the relationship between operational logistics and maintenance activities, and develop knowledge for follow-on implementation.

Phase 2 of the FAA implementation program involves installing approximately 900 ground systems over a 10-year period. The objective of this phase is to install an MLS on every runway that presently qualifies for a precision approach system.

Phase 3 consists of an additional 300 systems procured over a 3-year period and provides for the future requirements of precision approach and landing systems. Each of these ground systems, together with its associated approach and runway lighting, represents about a $1 million investment. The total cost of all three phases is estimated at $1.1 billion in 1981 dollars.

The MLS is a very compact precision approach system that requires very little site preparation. The only requirements are a concrete pad and proper electrical power. This elevation station is at Jasper-Hinton, Alberta, Canada. Photo courtesy of Hazeltine Corporation.

Conclusion

Over 20 years ago, aviation planners began to realize our primary precision approach and landing system, the ILS, was extremely limited in its capability to meet future aviation requirements. This led to a worldwide technical effort that eventually identified the MLS as the system best qualified to replace the aging ILS.

The ICAO has adopted international standards for the MLS and prepared a worldwide ILS/MLS transition plan which should be complete by the year 2000. In conjunction with this international plan, the United States is involved in an aggressive program to install 1,250 MLS facilities in addition to over 250 military MLS ground systems.

The MLS is an excellent system and seems to be the proper choice to replace the ILS. As with any project of this scope, however, there is opposition that cites high cost and possible obsolescence as major drawbacks. This may be true, but the same faults would be associated with any project of this type in today's economy and with the present level of technology. Regardless of what system is proposed, a replacement for the ILS is required because of growing air traffic demands, and it seems the MLS represents the right choice at the right time. ■

THE AIR REFUELING SCENE

MAJOR RAY GORDON
Directorate of Aerospace Safety

■ The importance of air refueling to a fighter pilot becomes acutely evident when he's halfway across the "pond" and hears that his wingman has just "broken" the tanker's boom on a "breakaway" call. From daydreaming about home to the reality of the situation at hand is quite a shock. "Is there another tanker? No. How's the weather at my divert airfield, and can I get there with my fuel remaining? What is the status of my wingman?" As the tanker stows the boom and heads for home, the overused terms "reliability" and "safety" suddenly take on a more personal meaning. One of our goals in the safety community is to make air refueling as safe and reliable as possible. However, safety still depends on the knowledge and proficiency of the pilots and boom operators that conduct this sometimes risky business.

At first glance, 1985's air refueling mishaps seem relatively unimportant. It could be argued that this is just the cost of doing business. I don't agree. The potential for an aircraft loss is definitely present. Historically, 4 tanker and 13 receiver aircraft have been destroyed during air refueling operations. In many cases, the causes of 1985's Class C mishaps are the same as those Class A mishaps. This article will address these similarities. First, we'll look at 1985's refueling mishaps, and then we'll address the Class A mishap history.

1985 Air Refueling Mishaps

Mishaps during air refueling account for the largest single category of Class C mishaps for the KC-135 and KC-10. In 1985, KC-135 and KC-10 tankers and receivers reported 38 Class C air refueling mishaps, for a rate of over 13 mishaps per 100,000 flying hours. This rate has remained fairly constant during recent years. These mishaps can be broken down into two categories: Mishaps caused by boomer/receiver operational errors; and mishaps caused by air refueling systems malfunctions. Of the 38 mishaps in 1985, 87 percent were caused by boomer or receiver errors, and 13 percent were due to systems malfunctions. Additionally, the boom system was involved in 21 KC-135 and 7 KC-10 mishaps, and the probe and drogue system was involved in 8 KC-135 and one KC-10 mishaps.

Outlined below are last year's KC-135 air refueling mishaps by type aircraft.

Table 1
KC-135 Air Refueling Mishaps by Type Aircraft (1985)

Receptacle-Equipped Receivers	
C-141	5
KC-10	3
C/KC-135	2
RF/F-4	4
F-106	2
F-15	2
A-7	1
Drogue-Equipped Receivers	
F-14	4
F-4	2
A-6	1
F/A-18	1
KC-135 Systems Mishaps	3
Total	30

Of the 30 KC-135 reported mishaps, 10 occurred while refueling heavy aircraft, 9 occurred while refueling fighters, and 8 more occurred while probe and drogue refueling with Navy and Marine re-

continued

ceivers. Except for the three systems malfunctions, all were classified as receiver pilot or boom operator errors. Particular problem areas were associated with refueling the C-141, KC-10, and RF/F-4. The recognized difficulty in refueling with the KC-135 boom drogue adapter was again evident for Navy and Marine receivers. In both the heavy and fighter aircraft categories, the major problems were exceeding the air refueling envelope limits while in the contact position and brute force disconnects. In the probe and drogue category, the major problem was off-center basket engagements and disconnects. In one mishap, a Marine F-4 went home with a shattered windscreen from a drogue strike.

In addition, three air refueling systems failures were reported. Fortunately, none of these were compatibility problems with receiver aircraft.

Listed below are last year's KC-10 air refueling mishaps by type aircraft.

Table 2

KC-10 Air Refueling Mishaps by Type Aircraft (1985)

Receptacle-Equipped Receivers	
RF/F-4	4
F-15	1
F-111	1
KC-10 Systems Mishaps	
F/A-18 (Drogue)	1
Other	1
Total	8

The KC-10 had eight Class C air refueling mishaps reported in 1985. Four F-4 and one F-111 receivers had their air refueling receptacle damaged by the KC-10. (Three of these involved hard contacts, and one receiver disconnected at the lower/inner limit which caused the boom to whip resulting in damage to the receiver.) Another mishap involved a probe and drogue system malfunction. The hose reel takeup system apparently failed, and the resulting hose oscillation broke a Marine F/A-18's probe. (This type of failure also caused a 1984 Class A Marine A-4 mishap.)

The solution to our air refueling mishaps doesn't rest with the tanker crews or the receiver crews. All crewmembers must know and follow the proper procedures. No matter how many times you've done it, air refueling can't be taken for granted.

Conversely, the KC-10's air refueling boom was damaged in two mishaps. The first was a system malfunction where the polarity of the boom roll position transducer was reversed. This caused uncommanded rapid roll oscillations and resulted in damaged boom components. The second mishap was another hard contact with an F-15 which damaged the KC-10 boom chain and sprocket drive.

Class A Air Refueling Mishap History

The air refueling Class A mishap history shows many of the same causes that were present in 1985's Class C mishaps. First we'll look at the KC-135 mishap history, and then we'll address the KC-10 history.

KC-135 Mishaps

The KC-135 has been involved in 12 Class A air refueling mishaps. In each mishap, a receiver aircraft was destroyed. In four of these mishaps, the KC-135 was also destroyed. Sixteen receiver and sixteen tanker crewmembers were fatalities as a result of these mishaps. Nine of the twelve mishaps occurred during the 60s. One each occurred in the 50s, 70s, and 80s. Listed below is a synopsis of the KC-135 air refueling Class A mishaps.

Receptacle-Equipped Receiver Mishaps

All three B-52 mishaps occurred because of an overrun condition. In each case, an IP failed to take the necessary action in time to prevent the overrun from occurring. In both B-47 mishaps, pilot technique/judgment was a factor. In one, the B-47 pilot overran the KC-135 during the rendezvous and lost visual contact. Instead of remaining at his required altitude before reacquiring the tanker, the receiver started a climb and collided with the KC-135. In the other B-47 mishap, the pilot attempted to expedite his move into the precontact position from a wing observation position and collided with the tanker.

In the two F-4 mishaps, poor technique and supervision were factors. In the first, a brute force disconnect with a resulting boom whip damaged the F-4 extensively enough to dictate ejection. (The IP was late in taking aircraft control to prevent this mishap.) In the other F-4 mishap, supervisors did not provide appropriate supervision concerning a below average student pilot for his first solo air refueling. The student pilot approached an inner limit, and the boom operator initiated a disconnect. As the F-4 pilot started back, he induced a PIO. The ensuing collision broke the boom off, damaged the tanker's tail section, and shattered the F-4 canopy. Both F-4 crewmembers ejected immediately following the collision.

The F-105 mishap was a midair collision during the rendezvous. Both the tanker and receiver aircrews made variations from established rendezvous procedures which led to the midair collision. The F-105 flight leader failed to see the KC-135 in sufficient time to take necessary evasive action. As the F-105 flight lead evaded above the tanker, No. 3 escaped below the tanker while the No. 2 aircraft and the tanker collided and were destroyed.

Probe-Equipped Receiver Mishaps

Four probe and drogue air refueling Class A mishaps have also occurred with the KC-135. In one, a Navy crew ejected after their TA-4 experienced engine explosions due to ingested fuel from a torn boom drogue adapter (BDA) hose. A combination of pilot error and BDA design/maintenance deficiencies were factors in this mishap. In another BDA mishap, the hose separated from the tanker and remained on an F-105's probe. This subsequently broke the F-105's canopy and caused the engine to flame out, which could not be restarted. In this mishap, poor pilot drogue engagement technique and design deficiency were factors.

Table 3

KC-135 Class A Refueling Mishaps

Receptacle-Equipped Receiver Aircraft (Total 8)			
B-52F	B-52D	B-52G	B-47E
Overrun Night Ejection Both acft destroyed	Overrun Boom hit wing Wing separated on landing Fire	Overrun during AR Both acft destroyed	RZ overrun Lost sight of tanker Climb into KC-135
B-47E	F-4C	F-4C	F-105D
Collision while moving into AR position Both acft destroyed	Poor pilot technique Brute force Boom whip Struck F-4 Eject	Inner limit PIO Struck boom & tail Ejection	Midair during RZ Procedures Both acft destroyed
Drogue-Equipped Receiver Aircraft (Total 4)			
TA-4J (N)	F-105D	RF-101C	F-100F
BDA hose tear Fuel ingestion Engine explosion Ejection	Hose tear Broken canopy Fuel ingestion Flameout Ejection	Overrun drogue Pitch-up Lost control Delayed ejection	Night Off-center disconnect Canopy shattered Ejection

In the F-101 mishap, the pilot overran the drogue basket and nosed-down to gain separation. The pilot then reversed his descent which continued into the classic F-101 uncontrolled pitch-up. During the recovery attempt, the pilot deployed his drag chute but a spin developed. Spin recovery was successful but improper dive recovery procedures and delayed ejection decision resulted in an out-of-the-envelope ejection fatality.

The F-100F mishap occurred during a student night refueling. An off-center disconnect occurred, and the air refueling drogue shattered the canopy. The broken plexiglas broke both pilots' visors and rendered communication unusable. Since both pilots had no means of protecting themselves from the severe wind buffet, the decision was made to eject.

KC-10 Mishap

Only one Class A air refueling mishap has occurred with the KC-10 aircraft. In this mishap, the KC-10's hose reel takeup system failed upon drogue contact with a Marine A-4. The resultant slack in the hose created an oscillation which broke the hose near the drogue basket. Fuel spilled out of the hose into the A-4's engine. A series of engine explosions dictated an ejection decision by the pilot.

Historical Comparison

There are many similarities between 1985's Class C mishaps and the Class A mishaps of previous years. Luckily, no Class A mishaps occurred last year.

Hardware improvements are being considered and accomplished to improve reliability and safety of both the KC-135 and the KC-10. However, it's only through strong training programs and supervision in both receiver and tanker units, combined with diligence and adherence to procedures by all crewmembers, that we can continue to prevent Class A air refueling mishaps. If we *all* learn from the mistakes of the past, we won't be destined to repeat them. ■

FIRECRAFT

MSGT LEROY MILLER
3612 CCTS
Fairchild AFB, WA

■ Fire — I will not forget watching the movie about the caveman and his quest for fire. Fire was the most valuable item man could possess. He fought for and over it. It gave him light, heat, and protection. It was his refuge and occasionally his enemy. Without it, man could not survive. Mankind has had fire for thousands of years. We have leashed it and put it in metal boxes called furnaces, yet we have not mastered it. As an instructor at the USAF Survival School, I was amazed at the great difficulty people had when it came time to build a fire.

To produce fire, there must be three ingredients — oxygen, fuel, and heat. Fire can be compared to the human body while running. You have to breathe in enough air to keep yourself going, eat enough food to provide the fuel, and initiate motivation — the spark to get it all going. Remove one of the ingredients, and the body will not move nor will a fire start. The key to success is proper balance.

We've all seen logs burn. Just split them once or twice and throw them on the fire. They'll burn, but only on a hot, roaring fire. Rarely can we start one of them with a match, spark, or even kerosene. We must begin with a smaller fuel (tinder). The smaller and finer the material, the easier it is to start. Always start as small as possible. Try using lint, cotton, cattail down, or very small wood shavings.

Have you ever started a cross-country automobile trip with a quarter of a tank of gas? Of course not. You need a full tank. The same with your tinders. A good rule of thumb is to collect three times more than you need. Experiment with different kinds. For starters, try using shredded birch bark or pitchwood. Pitchwood is located where the branch meets the trunk. It is the dead dry wood that contains sap and resin from the tree. Once you've gathered sufficient materials, you can begin the process of fire building.

Most of the time, we start fires with a match, occasionally something even smaller like a spark. When using a match, cup it in your hands to protect it from the wind. Since the flames burn upward, direct your spark or match to the base of the tinder on the upwind side.

Why think about oxygen? It's already in the air. This is where most of us go wrong. Just because there is oxygen in the air does not mean we are breathing it. We still have to inhale. Don't pile on twigs so they smother the fire. Like a fireplace or stove, your fire needs venting.

Once the tinders have ignited, slightly larger material may be placed on the fire. Some fire builders add kindling to the fire one stick at a time, letting it burn for awhile and then adding another piece. The problem is, single sticks don't produce enough heat and fuel to let your fire feed itself. It is important to add a sufficient quantity of kindling to the fire so there is something to burn, without smothering it. Finally, after you have a large blaze, begin adding increasingly larger pieces of kindling.

By using a thong of dry rattan or other long, strong fiber and rubbing with a steady but increasing rhythm, you can start a fire by friction — or by running a stick back and forth in a groove.

Other ways to start a fire include lighting a cigarette with sunlight, using a convex lens to concentrate the sun's rays on tinder, or striking a rock or flint against steel.

Be sure you stack your kindling so it can get plenty of air. Block the wind with your body until the fire is started. Logs or rocks will provide a usable fireplace and can also be used to build a heat reflector.

The keys to firecraft are as easy to remember as the letter "p." They are:

■ *Preparation* — Whenever an outdoor trip is being planned, prepare for it. Gather dry tinders in advance, carry a small firecraft kit with you, and protect that kit. Remember, prior planning prevents poor performance.

■ *Patience* — If you have properly prepared your fire and gathered good dry tinder, your fire will start. Be patient, don't rush.

■ *Perseverance* — If you don't succeed the first time, keep trying. Regather good dry tinders and get plenty of them. Ensure you have plenty of wood shavings and twigs for the kindling. Don't forget to gather a good supply of fuel. Gather enough to last you the night.

■ *Practice* — Try a variety of tinders to see what it takes to get them to burn. Practice adding kindling to the fire. Smother a few; it will do you good. Then set a goal: "I will build a fire out of all natural material with only one match." And work towards that goal. Your next goal could be one match in the rain. Then try a spark from a metal match.

One thing is for sure; too many people die or become injured from the cold every year. It doesn't have to be that way. Firecraft can be mastered, but you must recognize and gather the right materials. Most of all — practice. ■

For Distinguished Contributions

SAFETY

THE COLOMBIAN TROPHY

The Colombian Trophy was originally established in 1935 by the Republic of Colombia to recognize the Air Force group having the lowest aircraft mishap rate during the preceding year. The criteria originally established for the award have been modified but are in keeping with the donor's original intent to award the trophy annually for military aviation safety in a tactical organization. Today, the Colombian Trophy is awarded annually to a wing-level tactical organization for the most outstanding achievements in flight safety during the preceding calendar year.

THE COLOMBIAN TROPHY FOR 1985
4TH TACTICAL FIGHTER WING
Seymour-Johnson AFB, NC

The 4 TFW flew nearly 26,000 hours and 21,000 sorties in F-4 aircraft during 1985 without experiencing a single Class A or Class B aircraft flight mishap. This outstanding safety record, compiled while holding a dual-base commitment in Europe for two squadrons and the other squadron at Seymour Johnson Air Force Base, North Carolina, committed to rapid deployment throughout the world, attests to the professionalism of aircrews and dedication of maintenance and support personnel.

The Wing performed one of the most demanding training missions in the Air Force including nuclear strike, close air support, battlefield air interdiction, defense suppression, offensive and defensive counter air, as well as training for, and participating in, joint sea defense exercises.

The Wing participated in 17 different off-station exercises including Red Flag, Coronet Gladiator, Maple Flag, Crested Cap, Air Warrior, and Gunpowder and Gunsmoke air-to-ground weapons competition. They also participated in several local exercises including Solid Shield and a JCS-directed exercise that involved other North Carolina-based sister service units.

The Wing won best in TAC honors for the Equipment Maintenance Squadron and the Component Repair Squadron. The Equipment Maintenance Squadron also won best in the USAF.

The professionalism of aircrews, the daily hazardous mission, the excellence of aircraft maintenance, the realistic combat training environment, and the outstanding mishap prevention accomplishments of the 4 TFW fully meet the high standards established for the Colombian Trophy.

AWARDS During 1985

CHIEF OF STAFF INDIVIDUAL SAFETY AWARD FOR 1985

Presented to Air Force personnel who made significant contributions to safety during the previous calendar year.

MAJOR FRANCIS M. HARVEY
Military Airlift Command

Major Harvey served as Chief of Safety, 1550th Combat Crew Training Wing, Kirtland Air Force Base, New Mexico. His contributions to the development of a cockpit leadership training program led to increased awareness of human factor and operator error flight mishaps by wing aircrew personnel. His development of an Air Force occupational safety and health guidance brochure contributed to the elimination of training and documentation deficiencies. His safety leadership was instrumental in achieving dramatic reductions in off-duty military mishaps, on-duty civilian mishaps, and mishap costs.

CAPTAIN WILLIAM J. HAMMER
United States Air Forces in Europe

Captain Hammer served as Weapons Safety/Nuclear Surety Officer, 50th Tactical Fighter Wing, Hahn Air Base, Germany. His outstanding safety management of the largest weapons safety program in the European theater enabled the Wing to meet or exceed all explosives safety and nuclear surety requirements during 1985 and pass all higher headquarters inspections. His identification and elimination of a significant quantity distance problem in conventional bomb buildup procedures resulted in the bomb buildup operations being rated outstanding by inspectors.

CAPTAIN DALE T. PIERCE
Air Force Reserves

Captain Pierce served as Chief, Flight Safety Branch, 919th Special Operations Group, Eglin Air Force Base Auxiliary Field 3, Florida. His outstanding professional skill, leadership, and dedicated efforts contributed to the effectiveness and success of flight safety programs Air Force wide. His safety article, "The FSO's Corner," appears in each issue of the *Air Force Safety Journal* and has increased the crosstell between flight safety officers throughout the Air Force. His safety leadership enabled his wing to maintain a flawless flight safety record for the 14th consecutive year while participating in numerous exercises and deployments.

TECHNICAL SERGEANT GLENN R. MACFARLANE
Air Force Communications Command

Sergeant MacFarlane served as Additional Duty Ground Safety Noncommissioned Officer, 1916th Information Systems Squadron, Pease Air Force Base, New Hampshire. His outstanding professional skills and dynamic leadership contributed to major improvements in the squadron's safety posture. His development of the "Hot Stuff" Program ensured quick medical aid to Air Force Communications Command people by reducing squadron and hospital time significantly whenever an emergency occurs in high-voltage work centers. Through his safety leadership, the squadron has not had a motor vehicle mishap for 5 years, and reportable ground mishaps were reduced 85 percent.

ALTITUDE

Something old . . . something new

MAJOR BRITT MARLOWE
Directorate of Aerospace Safety

Historical

■ Altitude hypoxia did not evolve as a spinoff of increased aircraft service ceilings in the early 1900s; rather, this condition had its roots firmly established in the 1860s when ballooning was the rage. In fact, hypoxia was identified, and the use of oxygen became the established emergency procedure back in 1874 by Paul Bert, a French physician and the Father of Aviation Medicine.

Early hypoxia experiments were conducted in Bert's altitude chamber (Figure 1), which he designed and built. It had a capability of reaching a physiological altitude of 36,000 feet, although most of his experiments were conducted below 28,000 feet. Besides demonstrating the occurrence of trapped gas disorders (ears, sinuses, GI tract), he was able to show that subjects experienced increased respiration, lowered body temperature, reduced digestion, and listlessness.

Bert's curiosity in altitude physiology stemmed from his knowledge of the exploits of balloonists. In 1862, Glaisher and Coxwell ascended to 29,000 feet, resulting in Glaisher's unconsciousness and Coxwell's near unconsciousness. Fortunately, Coxwell was able to pull the balloon's relief valve in time to initiate a descent, which led to their recovery (probably the first reported Class C physiological mishap). Adventures like this led to Bert's research and finding that oxygen-enriched breathing mixture could protect against altitude hypoxia.

In 1874, Croce-Spinelli and Sivel, as well as a number of scientists and balloonists, received indoctrination training on the effects of altitude hypoxia in Bert's chamber. They be-

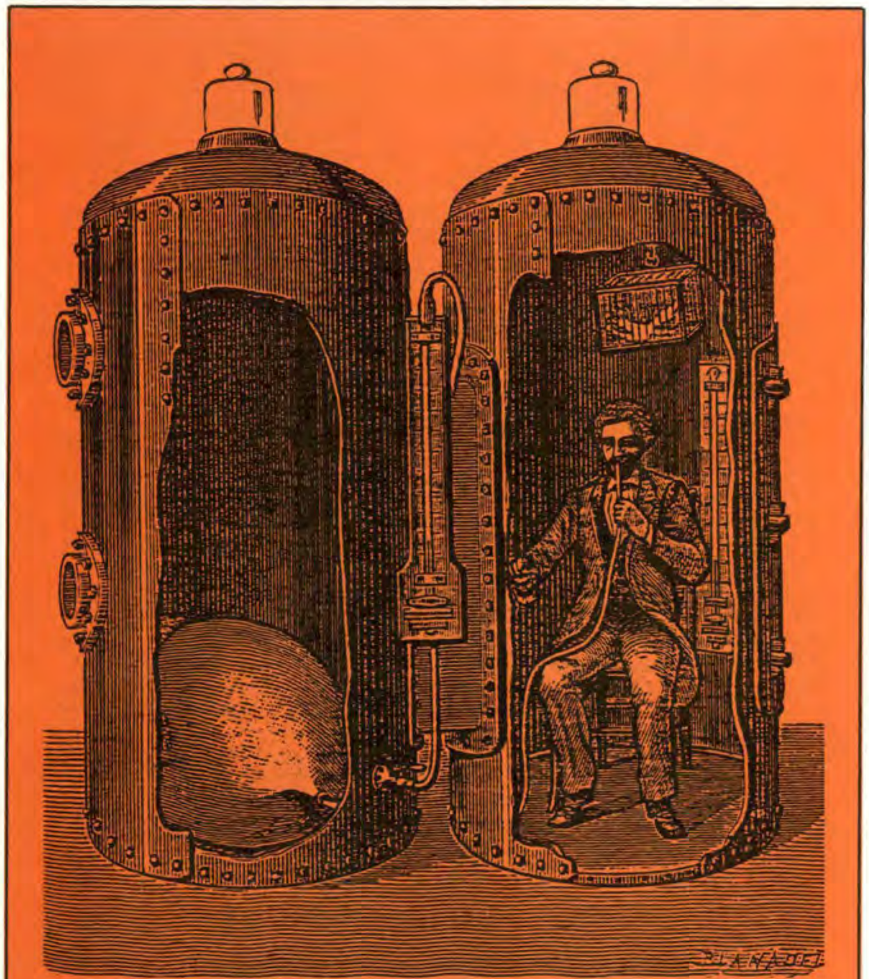


Figure 1. Dr. Paul Bert designed and built the world's first altitude chamber. Many scientists and balloonists received hypoxia training over 100 years ago. Dr. Bert also discovered other physiological effects such as trapped gas disorders, increased respiration, and lowered body temperature. He published the results in La Pression, Barometrique, Recherches de Physiologie Experimental in 1878/National Library of Medicine.

HYPOXIA

came listless, developed facial bluing, and experienced dim vision. As they breathed from Bert's oxygen-enriched bag of air, their symptoms cleared.

They were so impressed with these results, they took several bags of the oxygen-air mixure on their next balloon flight 2 weeks later. During the ascent to 24,300 feet, they periodically breathed from the bag to relieve their symptoms, not realizing the physiological requirement for continuous breathing of the oxygen enriched mixture at these altitudes. Their flight was uneventful.

In 1875, these now highly over-confident aeronauts attempted another flight with the goal of reaching 26,200 feet. They carried with them a third crewmember, Gaston Tissandier. Not realizing that the third individual would place a serious drain on their already inadequate oxygen supply, they ascended.

They assumed they could conserve oxygen by using it only when necessary. (Bert had already proved that continuous oxygen breathing was necessary at these altitudes.) By the time the aeronauts realized they did not have enough oxygen, it was too late. Tissandier wrote in his flight log, "Soon I wanted to seize the oxygen tube, but could not raise my arm, however, my mind was still

lucid . . . I wanted to cry out we are at 8,000 meters (26,200 feet), but my tongue was paralyzed. Suddenly I closed my eyes and fell inert, entirely losing consciousness. . . ." When he awakened, his fellow aeronauts were dead. Like Tissandier, they were unable to reach the oxygen tubes before they exceeded their time of useful consciousness. These were the first recorded deaths due to altitude hypoxia.

The Learning Curve

Since the time of Paul Bert, military aviation has come a long way in protecting the aircrew member from altitude hypoxia. For example, in the early 1920s, Macready flew at least 50 times to 30,000 feet in a LePere biplane. In an open cockpit, braving -83 degrees F and using oxygen flasks, the most significant obstacle he experienced was getting enough oxygen into the lungs.

The oxygen mask was developed shortly after this allowing pilots to reach altitudes up to 40,000 feet. Flight above this altitude required an oxygen system capable of delivering 100 percent oxygen with a positive pressure breathing capability, or totally sealing and pressurizing the cockpit. The first successful pressurized combat aircraft was developed by the British in 1941 — the Spitfire Mark IV. By the early 1940s, enough aeromedical information was known to start training aircrews in hypoxia recognition and emergency procedures.

Since this time, we've steadily improved oxygen regulators and masks, emergency procedures preflight and in-flight checks, and altitude chamber training. All of this has improved flying safety. We cannot prove or disprove the role of hypoxia in at least some Class A mishaps because there is no definitive after-the-fact test for it. Prevention still requires your vigilance.

No doubt, improved oxygen and cabin pressurization systems make it safer to fly above 10,000 feet MSL, but sometimes these systems fail! Checklist procedures require preflight, climb, and level-off checks to ensure your life support systems are functioning prior to reaching critical physiological altitudes. Are *you* consistent in your checklist procedures? Most pilots are. Some are not.

- **T-37** ACE copilot en route at 16,000 feet noted symptoms of hypoxia. He connected his mask improperly to his helmet and failed to perform ground and inflight checks of his oxygen systems.
- **C-130H** Training mission. During repressurization on climb through 16,000 feet, crew came off oxygen assuming cabin pressurization was functioning. The flight engineer failed to monitor pressuriza-

continued

tion system failure, and three crewmembers performing heavy work in cargo compartment suffered hypoxia.

■ **A-7D** Two-ship. After 10 minutes at FL 250, wingman noticed voice changes in lead. Moved to close formation and noticed lead's mask off. He directed mask on, 100 percent oxygen, descent. Flight entered weather, and wingman directed ejection if lead could not recover. Lead recovered aircraft at 6,000 feet after regaining consciousness. Lead dropped mask to blow nose, could not reconnect mask bayonet due to newly-issued type of mask and helmet configuration and lack of familiarization training. Cabin pressure inadvertently moved to dump position during flight. Failed to recognize hypoxia symptoms. Thanks to the wingman, this did not become a Class A mishap.

■ **C-130E** At FL 250, nav noted crew door open light on. Crew donned oxygen masks and AC performed emergency procedures. After depressurization, engineer removed mask and donned his harness to check door, failing to use a portable oxygen assembly. Engineer exhibited hypoxia symptoms and was directed to go on oxygen by nav and loadmaster.

■ **RF-4C** High altitude recce flight. Pilot noted fumes in front cockpit, and crew performed smoke and fumes checklist. During RTB, WSO dropped mask to troubleshoot source of fumes and developed symptoms of hypoxia.

■ **T-37** During spin prevent maneuvers, student displayed hypoxia symptoms. IP noted student's CRU 60/P was disconnected. Student either improperly connected CRU 60/P or it became disconnected during flight.

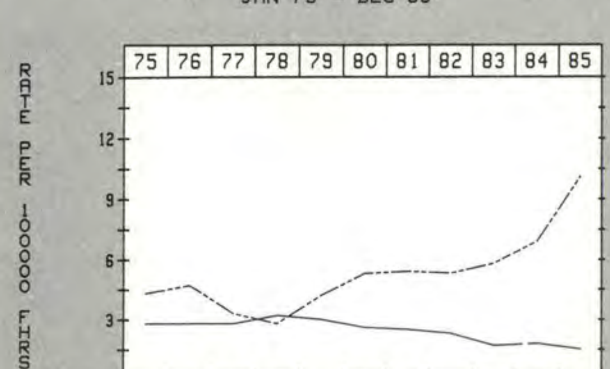
■ **T-37** Passing 19,000 feet, the student suffered hypoxia symptoms. The student had a poor mask fit and failed to perform pre-flight/in-flight checks. Oxygen regulator failed.

■ **A-10A** Aircraft was No. 3 of a 3-ship BFM and night air refueling mission. While in the observer position waiting to refuel, the pilot recognized hypoxia symptoms. He noted blinker on oxygen regulator was not working, performed emergency procedures, and realized he was not getting any oxygen flow, so he dropped out of formation and descended below 10,000 feet. His radio calls were sluggish. Maintenance found the oxygen regulator was improperly installed. Pilot failed to perform pre-flight/in-flight checks of the oxygen system.

■ **F-15C** Mission was night intercept. Pilot reached working area (FL 300 — FL 350), and after about 10 minutes, noted difficulty with the oxygen system. He accomplished PRICE check, went to 100 percent oxygen, and remained at altitude. Symptoms disappeared, and he turned the oxygen regulator back to normal. Cabin altitude read 15,000 feet (normal). He again felt hypoxia symptoms and selected 100 percent oxygen until symptoms disappeared, then selected normal oxygen and remained at altitude. He again felt all his symptoms, declared an emergency, performed EPs, selected 100 percent oxygen, and descended to 15,000 feet — just above the weather. He stayed above the weather for 10 minutes to burn down fuel, then made a precision approach to an uneventful landing. The oxygen regulator had failed.

Figure 2

USAF CLASS A MISHAP RATES
CLASS C PHYSIOLOGICAL MISHAP RATES
JAN 75 - DEC 85

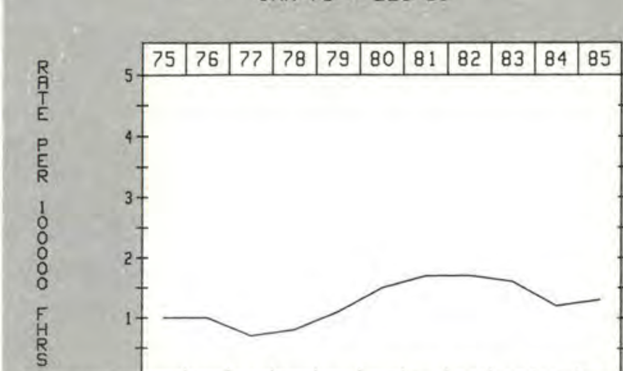


	75	76	77	78	79	80	81	82	83	84	85
PHYSIO	4.3	4.7	3.3	2.8	4.2	5.3	5.4	5.3	5.8	6.9	10.1
CLASS A	2.8	2.8	2.8	3.2	3	2.6	2.5	2.3	1.7	1.8	1.5

PHYSIO - - - - -
CLASS A ———

Figure 3

USAF
CLASS C MISHAPS - HYPOXIA
JAN 75 - DEC 85



	75	76	77	78	79	80	81	82	83	84	85
NUMBER	34	30	23	25	34	48	56	58	56	41	46
RATE	1	1	.7	.8	1.1	1.5	1.7	1.7	1.6	1.2	1.3

RATE ———

Figure 4
Number of Reported Hypoxia Mishaps And Aircrew/PAX With Symptoms By Aircraft Category
1975 - 1985

YR	TNR	FAR	OBS	BMBR	CGO	U/H	TOT
75	21(21)	5(5)	—	2(2)	6(21)	—	34(49)
76	11(13)	10(13)	—	2(2)	7(11)	—	30(39)
77	6(6)	10(11)	—	4(16)	5(10)	—	25(43)
78	11(14)	5(5)	—	3(4)	6(14)	—	25(37)
79	19(19)	6(7)	—	4(14)	5(12)	—	34(52)
80	29(30)	6(7)	—	6(18)	7(11)	—	48(66)
81	37(41)	10(11)	—	5(10)	4(12)	—	56(74)
82	30(32)	13(15)	1(1)	5(10)	8(11)	1(1)	58(70)
83	30(31)	12(12)	1(1)	2(2)	10(31)	1(1)	56(78)
84	26(27)	7(7)	—	2(10)	6(21)	—	41(65)
85	26(27)	11(12)	—	4(14)	5(9)	—	46(62)

( ) = Number of aircrew/PAX with symptoms.

Figure 5
Reported Hypoxia Mishaps By Year And Cause
Jan 1975 - Dec 1985

YR	OPR	LOG	ENV	UND	TOT
75	12	16	5	1	34
76	4	17	2	7	30
77	3	15	5	—	23
78	4	14	1	6	25
79	7	23	2	2	34
80	2	38	5	3	48
81	9	35	6	6	56
82	9	26	15	8	58
83	4	44	5	3	56
84	9	25	2	5	41
85	9	31	—	6	46
Total	72	284	48	47	451

Symptoms occurring three times on the same sortie is two times too many.

Class A or Class C . . . Your Choice

All of the above mishaps were Class C physiological hypoxia episodes where the crewmember recovered. All of these were ops error mishaps. So what? The aircrew recovered, no aircraft were destroyed, and no one died. They were *only* physiological mishaps! Unfortunately, this attitude prevails in some aircrews, fostered by lack of knowledge, judgment, inattention to procedures, or complacency.

There is an association between Class C physiological and Class A flight mishap data (Figure 2). Since 1975, the physiological mishap rate has increased, while the Class A rate has decreased (excluding 1977 and 1978 when there was a reduction in pilot training).

Those of us in the Life Sciences Division feel this inverse relationship is due to improved reporting resulting from better recognition of in-flight emergencies by aircrews. How many Class C hypoxia mishaps would have been Class As had not the aircrew recognized their symptoms? We can't say.

Class C mishap reporting is an effective means of Class A mishap prevention because we have the aircrew member to tell us what piece of equipment failed, which procedure was not performed, which procedure was inadequate, or how training influenced his recovery. We can then act on an appropriate fix. It is part of a surveillance system designed to monitor known flying safety hazards as well as to ensure identification of new ones. Altitude hypoxia falls neatly into the category of a known and effectively prevented hazard as evidenced by the fact that although Class C hypoxia mishaps are up, the USAF hasn't experienced a known Class A hypoxia mishap since 1982.

The USAF Class C hypoxia mishap experience is shown in Figure 3. Figure 4 identifies this experience by year and aircraft category and clearly shows that trainers and fighter/attack aircraft have the greatest number of mishaps. Reported Class C hypoxia mishaps by year and cause are found in Figure 5, and Figure 6 lists the breakdown of operator errors.

continued

Figure 6
Operator Errors Resulting in Hypoxia
Jan 1975 - Dec 1985

Improper PRICE check	35
Improper equipment use	10
Removed oxygen mask during flight	7
Inadvertently turned regulator off inflight	5
Procedural error	5
Depleted oxygen, improper EM switch setting	3
Improper M-1 (no loc)	2
Failure to monitor cabin altitude	1
Materials stored in helmet bag	1
Self-medication	1
Improper adjustment of oxygen hose retention strap	1
Heavy smoker, subnormal oxygen carriage	1
Total	72

NOTE: Data obtained from mishap forms 711gA/711gC.

Altitude Hypoxia continued

F-15C Class A Hypoxia Mishap

The mishap flight was the pilot's 10th ZULU tour, but only his second scramble. He arrived well-rested, well-prepared, well-nourished, alert, in good spirits, and eager to fly. Following briefing and preflight, he ate breakfast and watched TV until the scramble signal. He ran to the aircraft, strapped in, and attempted to taxi while still in the chocks.

During departure, an ops check was performed at too low an altitude to register lack of pressurization. The flight climbed through 14,000 feet and peaked 2 minutes later at FL 270, then descended into the TRA for intercepts during which the mishap pilot's altitude varied from 14,000 feet to FL 220 over the succeeding 13 minutes.

Actions, transmissions, and responses by the mishap pilot clearly demonstrated progressive impairment. He entered an erroneous squawk code and when prompted to correct it, entered still another erroneous code. Despite directions from lead plus two calls from GCI, he proceeded to an erroneous point for his first intercept, then asked lead "What point is . . . ah . . . 02 cleared to?" When called to confirm proper function of his navigation equipment, he merely acknowledged the call. He missed several radio calls, and several of his transmissions sounded lethargic and incomplete and frequently appeared to mimic calls made to him. When lead called for an ops check by transmitting his fuel status, the mishap pilot responded with "two."

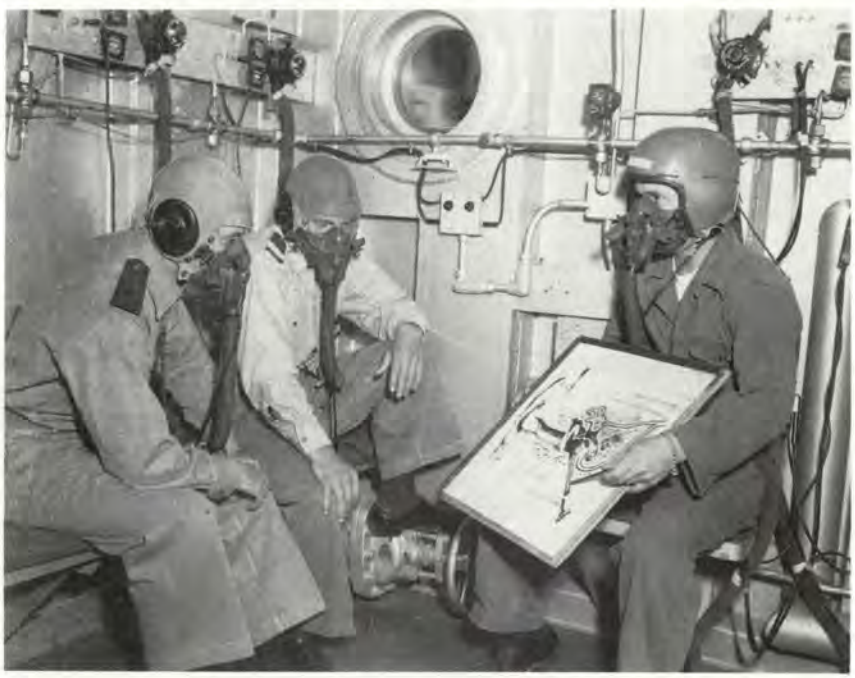
He did conduct his one intercept successfully. This was a fairly easy stern conversion requiring no maneuvering other than GCI directions. However, on subsequent rejoin, he slowly drifted beneath lead, and when asked if he was visual replied, "negative." Lead provided his location. Mishap pilot called "visual" and moved out into a position where he was directly down sun from lead. At this point, the flight had been cleared to FL 360 and was climbing through FL 240 when lead told mishap pilot to "take it up." Lead then observed the mishap pilot 30-degrees nose high passing FL 265, apex at FL 330, and arc over into a 70 degree dive without responding to radio calls.

The mishap aircraft failed to pressurize on the two prior flights, yet no mention of this appeared in the aircraft forms. On one prior flight, another pilot noticed his hypoxia symptoms at FL 250, yet failed to mention this after flight. Cockpit depressurization alone would not cause hypoxia, if the pilot was properly connected to a functional oxygen regulator.

Oxygen regulator and communications indicated the mishap pilot's mask was on and that he was not hyperventilating. Damage to the CRU 60/P prongs indicated that it was connected. The oxygen regulator supply hose was connected. Had the quick disconnect come loose, the mishap pilot should have noted the restriction to inhalation. This implies the oxygen regulator failed to increase oxygen concentration with altitude. This hypoxia resulted from the failure of both the aircraft pressurization system and the oxygen regulator, unrecognized by the mishap pilot, flight lead, or controllers.

Something Old, Something New

There is a remarkable similarity between the first altitude hypoxia deaths occurring on the Croce-



This picture shows how much we had progressed by the 1950s. Oxygen masks, regulators, and many years of research had given us a much improved ability to deal with the physiological effects of high altitude flight. Today, our equipment and training are even more advanced. Instead of a generic program for all crewmembers, our physiological training is tailored to the type aircraft being flown.

All the equipment, training, and procedures are designed to provide the flier with the capability for safe flight at high altitudes. But, it's all finally up to you. Do you understand the equipment and procedures, and do you use them properly?

Spinelli, Sivel, and Tissandier balloon flight in 1875, and the F-15C Class A hypoxia mishap in 1982, over 100 years later:

■ **Altitude Chamber Training** Both the aeronauts and the pilot received training (prior to flight) where it was adequately demonstrated to them that altitude hypoxia could be recognized and that use of an oxygen-enriched breathing mixture can prevent hypoxia.

■ **Preflight Check** They failed to properly check their oxygen requirements and systems. During flight planning, the aeronauts failed to take into account the additional drain by Tissandier on their already inadequate oxygen-air breathing mixture, failing to take enough oxygen-air mixture with them. The F-15 pilot's oxygen system failed (could have possibly been identified during ground PRICE check which was probably not accomplished during scramble).

■ **Unpressurized Flight** In both mishaps, the aeronauts and the F-15 pilot were exposed to unpressurized flight. The F-15 pilot could have identified pressurization failure at a safe altitude if a proper ops check had been accomplished.

■ **Oxygen Discipline** In both mishaps, failure to use oxygen systems appropriately contributed to the mishap. To conserve their only oxygen, the aeronauts used it only when they experienced their symptoms, failing to use it continuously as previously required. The F-15 pilot failed to ensure his oxygen system was functioning correctly during flight.

■ **Improper Crew Coordination** In both mishaps, failure to respond to a crewmember's difficulty contributed to the mishap. The aeronauts' failure to monitor each other's performance during the flight (buddy system) resulted in failure to recognize the emergency and initiate a descent to a safe altitude. The lead F-15 and ground control failed to direct the mishap pilot although they had early voice and behavioral cues indicating he was having difficulty. There were no directed oxygen or pressurization checks.

■ **Time of Useful Consciousness** The operators in both mishaps failed to recognize symptoms in time and perform appropriate emergency procedures prior to incapacitation.

Summary

In each of the nine Class C hypoxia mishaps cited above, more than one of the ops errors identified with the fatal balloon and F-15 mishaps were present. The main difference is that early recognition of symptoms and performing the correct EPs resulted in recovery rather than a fatality.

Hypoxia is *something old,* not *something new!* It's been with us ever since man left the safety of a sea level environment. *Hypoxia mishaps are consistent repeats of previous mishaps.* The vast majority are due to equipment failure, and the outcome is a function of pilot discipline. We can improve systems and equipment, but how do we reduce those mishaps attributed to faulty human performance — errors of procedure, recognition, or attention? These are precisely the same human factors we see associated with 60-70 percent of all Class A flight mishaps.

We believe operator error hypoxia mishaps can be reduced by:

■ Completing proper preflight, climb, and level-off checks of your oxygen and cabin pressurization systems.

■ Knowing when to use your emergency oxygen systems.

■ Having your emergency procedures down "pat."

■ Developing good crew coordination should a crewmember or wingman become hypoxic.

We are not sure whether to expect the number of reported Class C hypoxia mishaps to continue to rise. What we don't want is a Class A that should have been a Class C. It's your choice! ■

. . . But Not The Boldest

It is a long time since anyone has been taught to fly by the seat of his pants. But today's Air Force, with its safety regulations, radio navigation aids, and highly specialized equipment which take the guesswork out of flying, had its evolution in the painful experiences of pioneer airmen who depended more on guts than on gauges.

The experiences of most any of the old-time military aviators will tell the story of how our Air Force has developed its high standards of safety, its emphasis on training, and its refinements in planes and equipment. One such pilot is Warrant Officer Chester F. Colby who first soloed as a staff sergeant in 1919 in a Curtiss Jenny. Since then, Colby has amassed a respectable total of well over 11,000 hours flown in 91 different type and model airplanes.

Mr. Colby began his flying career at Mitchel AFB. In those days, the CO could authorize flight training for members of his command who he thought could fill the bill. His commanding officer at Mitchel selected one officer and four enlisted men as potential pilots.

This month's article was printed in *Flying Safety* in 1948. It's interesting to look back at what a veteran pilot had to say almost 40 years ago about the great progress in aviation up to that time. The hardware he saw as modern, we now see as antiquated.

What is even more interesting is his comparison of the "boners" pilots pulled in the 1920s and in the late 1940s. Have we really made much progress here? Compare those "boners" with some of our modern ops factor mishaps.

"If you didn't solo within 4 hours," says Colby, "you were considered to be hopeless in those days."

After building up the staggering total of 85 hours, Colby was tapped as an instructor for the Observation School at Ft Sill, Oklahoma. Captain Walter Krans and Major Clarence Tinker were Colby's first two students. Both of these men wore generals' stars in World War II.

While planes and rules have changed a lot since those early days, Colby believes pilots then and now pull the same kind of boners — buzzing, maneuvering the plane beyond sensible limits, and ignoring rules and regulations. Student pilots of today, on team rides, who test each other's intestinal fortitude are not doing anything new.

Colby cited a few incidents which occurred in the 1920s. Two students went aloft in a DH-4 to settle an argument. The boy in the front seat kicked the airplane into a spin, telling the other student that the first one to touch the controls to effect a recovery was yellow. Result? Both those "brave" men luckily escaped without a scratch, but the DH-4 was salvaged for kindling.

Another student got on the tail of a buzzard while flying a DeHaviland. The buzzard reefed it in a wee bit too tight for the DeHaviland which promptly spun. Some foolish pilots today make the same low-speed, tight turn on the base leg.

When it became apparent that airmen couldn't always walk away from a crash, the parachute was introduced. In 1922, Colby strapped on his first chute. This model came packed with tissue paper between the folds of silk. The paper had the same purpose as our pilot chutes attached to the jumping bags of today. Colby tells about a CO, later a general, who wrote to the War Department requesting that parachutes be done away with since they encouraged pilots to abandon government property. Although Colby has never qualified as a caterpillar himself, he says, "I've had one foot over the side several times."

The radio aid to navigation which today's flier takes for granted had interesting beginnings.

A few months after the installation of the first radio range in North Carolina, Colby was flying a C-9 transport in the area of Greensboro. He had been following the beam and thinking of the great strides that had been made in navigation when suddenly a voice came over the head set, "This is Greensboro Radio, severe thunderstorm north of Greensboro, we're going off the air." There was Colby, high and not dry, without radio facilities, all because the folks on the ground were afraid their brand-new radio range station might be damaged by lightning with them in it.

When the storm had passed, the range operator returned from his hideaway in the nearest barn to his switchboard and put Colby back on the beam.

Aside from torn fabric and split props incurred during the earlier days when any race track was a landing field, this veteran pilot has had only one major aircraft accident. It was during the summer of 1927 that he wrapped up a C-1 transport. Colby was flying supplies to tornado stricken residents in Rock Springs, Texas. While he dragged a pasture for landing, the engine quit, and Colby, making the best of a bad situation, crash landed the C-1 in a cedar brush patch. No one was hurt, but the C-1 was more than somewhat dented. During the past 21 years, Colby has not had a single accident in 7,800 hours of flying.

We don't land our modern fighters in the grass like this Sopwith Camel is preparing to do. But, our pilots can still make some of the same mistakes as the early pilots.

To what does an old-time pilot like Colby give credit for such a clean record?

"Flying is like anything else a man will do," he explains. "There are certain chips stacked against you. If I don't feel the hand I hold is better than the odds against me, I don't bet. The pilot who neglects his flight planning is certainly playing the 'chump' to say the least. My pet peeve is the pilot who shows up about 15 minutes before takeoff time; hardly looks at a weather man; doesn't check his maps, load, or airplane; and *thinks* he's ready for a thousand-mile trip."

A few excerpts from the log of a cross-country from San Antonio to Boston, flown by Sergeant Colby in 1924, make a good yardstick to measure the tremendous strides made in aviation since that flight was made.

"San Antonio to Dallas, Texas, 248 miles, elapsed flight time 3:45."

"Picked up railroad and inter-urban which parallels course."

"Engine spitting, showing effect of commercial gas."

"Flying field recently plowed. Unsuitable for landing."

"Radiator water blowing back on spare tire."

"Landed in pasture."

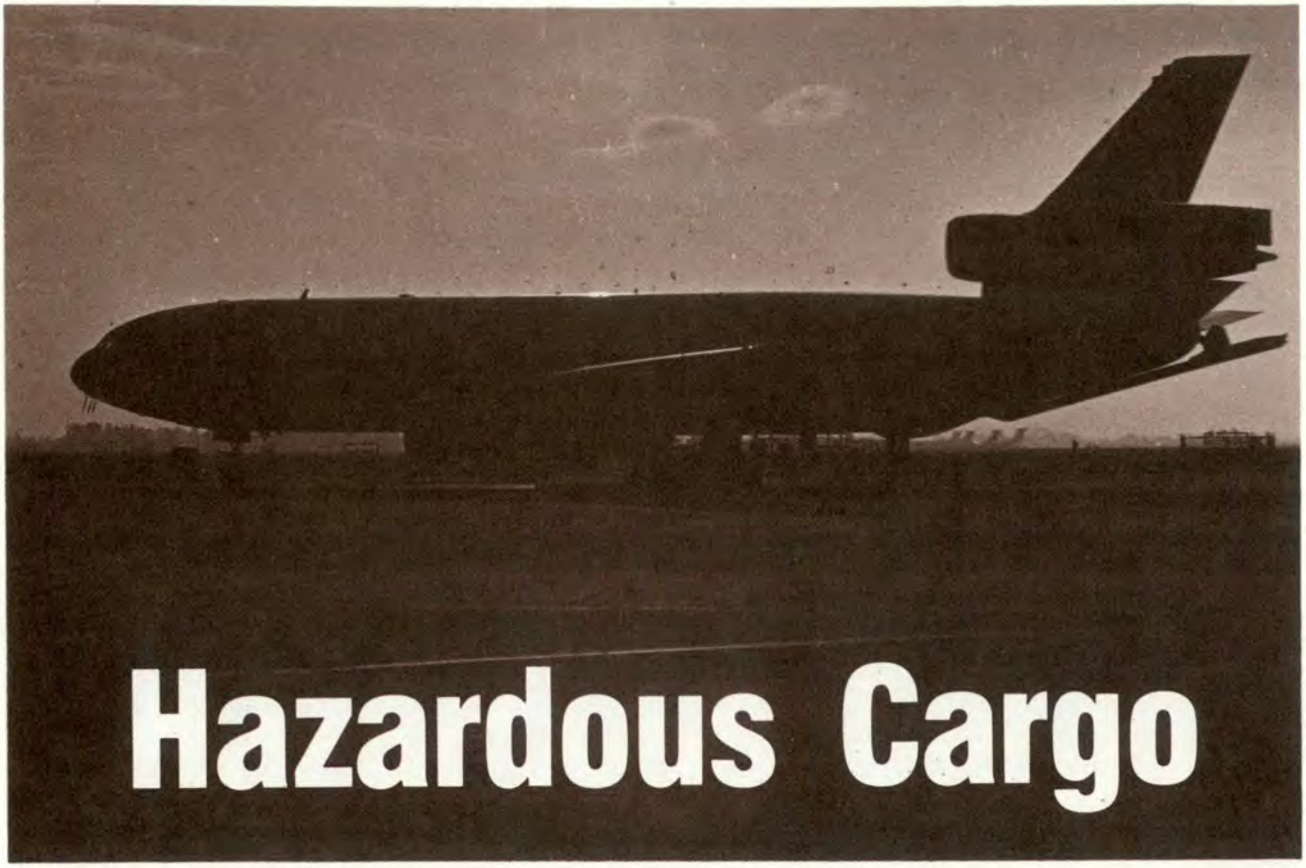
"Removed four fence posts and took off."

"Engine ran smoothly as long as left wing was held low. Removed spoonful of rubber from carburetor."

"Another radiator leak."

"Landed at Bolling. Field hard and in good condition."

As Colby puts it, we've come a long way. Where we go from here depends upon how well we align experience with initiative. — Reprinted from *Flying Safety* magazine, Sep 48. ■



Hazardous Cargo

MSGT VIRGIL D. ANDERSON
In-flight Refueling Superintendent, KC-10
77th Air Refueling Squadron (AFRES)
Seymour Johnson AFB, NC

■ A KC-10 was onloading cargo at Base X when a pallet of Class C explosives (small arms ammunition) dropped off the back of a K-Loader. (Murphy's law prevailed, and Murphy hadn't put the lock up.) Now, consider this, Mr. Boom Operator! The cargo was tied down with a top net and supplemental straps, and although the pallet fell about 4½ feet and landed on the pallet edge, the cargo was not touched and did not move. *Would you take the cargo?*

First, let's examine what we know about hazardous cargo. If it fits through the door, won't go through the floor, and the paperwork is signed, we don't have a worry in the world. Right?

Secondly, loadmasters get AFR 71-4, *Preparation of Hazardous Materials for Military Air Shipment*, training. If boom operators were supposed to know, somebody would have set up some kind of training for handling hazardous materials. Well, would you believe we are the somebody?

Going back to the first paragraph, the boom operator ordered the area evacuated and notified the MAC ALCE who, in turn, notified safety, and they removed the pallet of ammunition. AFR 71-4, Paragraph 1-3c states: "Explosive Item. In the event an explosive item is dropped or struck, the transportation or packaging office will immediately contact safety or munitions personnel to determine disposition."

The person in charge of the movement approached the boom operator and, with much logic, stated, "Look Top (short for top sergeant), it's only tracer ammo, and if it was going to go off, it would have by now. The ammo wasn't even touched. I'm signed for that stuff, and it's gotta go back on the airplane."

Well, everybody knew the individual was right. Everybody, that is, but you know who ("Murphy")! The boom operator stuck to his guns and politely refused the load.

AFR 71-4 does have something else to say about explosives and ammunition in Chapter 5, Paragraph 5-2d: "Forbidden Explosives:

(1) Shipments of explosives herein listed must not be offered for military airlift except as provided in subparagraph (3) below: (subparagraphs (a) through (d) omitted)
   (e) Leaking, dropped, or otherwise damaged explosives and ammunition.
(2) Leaking or otherwise damaged shipments of explosives and ammunition must not be repacked by terminal personnel unless in the presence of an appropriate technical ammunition inspector or other qualified personnel.
(3) Onward shipment of suspected or damaged explosives may be made; provided the shipment is certified on all DD Forms 1387-2 covering the containers involved that the shipment has been inspected and repacked in proper condition for safe transportation. Certification must be

There are a lot of hazardous materials being shipped by air, and what we don't know can definitely hurt us. Boom operators and other crewmembers need to know what is being loaded on the aircraft and ensure the cargo is safe.

signed by the appropriate technical ammunition inspector or other qualified personnel."

Allow me to give you another example of how fast you can get yourself hurt in the cargo world. On this occasion, I was inspecting a second load of cargo when I noticed two large padlocked connex metal shipping boxes. I asked that they be unlocked so I could inspect them for hazardous material. I was told some sergeant at the destination point was the only one who had the keys.

Now listen to this fairy tale: "Listen, Sarge, I just inspected both boxes, and I guarantee there is no hazardous stuff in there — just some tools. Trust me!"

I would not load the connexes on the airplane until they were opened. There were 27, one-gallon cans of paint in one box and 3 one gallon cans of methyl keytone (MEK) in the other box. I just laughed and said, "I know that stuff wasn't there when you checked. The bad fairy must have put it in there after you locked the boxes. My kids used to blame everything on the bad fairy."

To add salt to the wound, a lieutenant jumped all over me because the MEK was in one-gallon cans with sealed lids, and he had in his hand a Dash 2 (DD Form 1387-2). I reminded the lieutenant that it was already 92 degrees F, and when we opened the first connex box, we almost passed out from the toxic fumes of the MEK. Believe me, the paint and MEK were really cooking inside that metal box.

See how easy it is to get set up? AFR 71-4 states no hazardous cargo will be loaded in containerized loads (connex, Milvan) and will not be accepted for airlift because the contents are not accessible. The lieutenant had a Dash 2 indeed, but Paragraph 3-10 states that labeling of hazardous material for tactical or contingency movement will be in accordance with Chapter 13. Cargo palletized on 463L pallets or warehouse skids will have *labels placed* on each *hazardous item* and *labels will be visible on the outside of the pallet.*

Personally, I would rather haul explosive material than chemicals. With explosive material, people seem to be more aware of the danger and treat it with greater respect. With chemicals, people just don't realize the real dangers of fire, smoke, toxic vapors, and corrosives when chemicals interact with themselves and other materials. Statistics show there are more mishaps with chemicals than with explosives.

There are a lot of hazardous materials being hauled around that can really hurt us, for instance, flammables, oxidizing materials, corrosives, compressed gases, poisons, etiologic agents, radioactive materials, and other regulated materials. What about loading different types of hazardous material on the same airplane? Can we take passengers? What is the transportation office's responsibility to the aircrew? What are our responsibilities toward hazardous cargo?

We are not expected to know everything in AFR 71-4, but there is a lot of information that does pertain to the aircrews. We are no longer just gas passers. We are getting more and more involved in the cargo and passenger business. To accomplish our mission safely, it is an absolute necessity that we develop a strong in-house training program on hazardous cargo.

Now I don't pretend to be an expert on hazardous materials; I wish I were. I do realize we need some help in this area. The 77 AREFS (H) Associate (AFRES), Seymour Johnson AFB, North Carolina, has developed an in-house course on hazardous cargo that we are more than willing to share. What we have done is extract information from AFR 71-4 that the boom operator and aircraft commander should know about loading and hauling hazardous materials. If you would like a copy of our program, please write to 77 AREFS (H)/DOB, Seymour Johnson AFB, North Carolina 27531-6005, or call AUTOVON 488-6683. ■

If all cargo was visible and clearly marked like this oxygen cart, there would be fewer problems. Don't accept unknown cargo or hazardous cargo that has been mishandled, mislabeled, or mispackaged.

OPS TOPICS

Good Grief — #28

■ . . . circled airport and made left hand standard pattern . . . So much chatter on UNICOM that I couldn't talk. People discussing airport celebration. I told people talking to talk trash on another frequency.

One pilot said, "Amen;" another said, "Plane on final is talking to nobody."

I replied, "I don't have to."

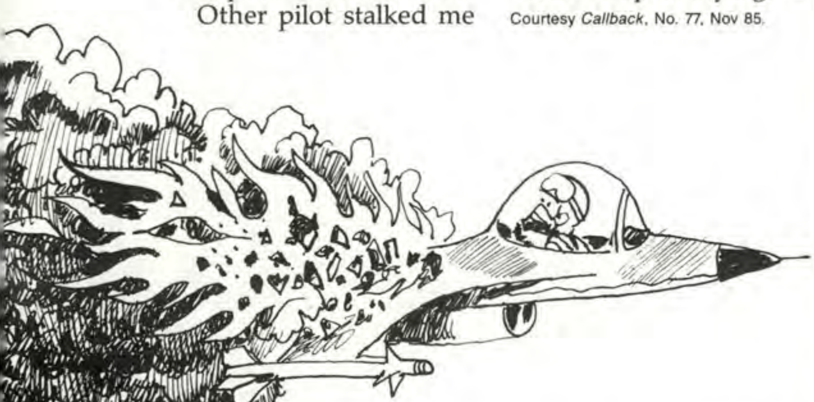
Another pilot told me to stick it in my ear. I told that pilot to stick it in his.

Other pilot stalked me to the ramp where I picked up two waiting passengers.

The other unknown and unwanted pilot tried to board my aircraft in what appeared to be anger.

My engines were both running so I blew him off the wing with max power to protect me and my passengers and took off. I was very courteous to traffic in pattern.

All participants in this rude imbroglio are hereby declared ineligible for the "Fellowship of Flying." – Courtesy *Callback*, No. 77, Nov 85.



Catastrophic Failure

As the F-16A pilot selected afterburner during takeoff, he heard and felt a large explosion from the rear of the aircraft. Interpreting it as an afterburner blowout, he initiated an abort.

Noticing an orange glow in the cockpit, he looked over his shoulder and saw a large flame blossoming out in a fan shape from a point halfway back on the fuselage. The reflections from the flames made it impossible for him to read the instruments.

As the pilot applied brake pressure, he discovered the brakes as well as the nosewheel steering had failed. The fire was spreading rapidly, the aircraft was drifting toward the right side of the runway, and the pilot was quickly running out of options.

The pilot ejected, the aircraft, with its aft end engulfed in flames, departed the runway and came to rest next to the BAK-9 barrier housing. The pilot landed about 30 feet behind the aircraft and rapidly departed the area.

The explosion was caused by the disintegration of the No. 1 fan disk in the engine. The debris severed the power takeoff shaft and hydraulic lines. It also punctured the oil reservoir, internal fuel cell, and the external centerline fuel tank resulting in a catastrophic fire. Some pieces of the No. 1 fan were found as far as 3,000 feet from the point of explosion.

In the Nick of Time

I have read many reports of near misses and other such episodes; this one is a near gear-up landing. It took me quite some time to figure out the whys and wherefores.

In a nutshell, I was preparing an applicant for a type rating. I gave him a simulated wing/wheel well overheat, requiring the gear to be lowered. The objective was to prepare him for a single-engine ILS. He did exactly what he should have done; he reached for the gear handle.

Since we were 8 miles from the VOR and he was to hold, I said, "OK, leave the gear 'til later" (mistake No. 1). He said, "OK." In his mind, the gear was down (NO. 2). I was expecting him to lower the gear at glide slope (GS) intercept (No. 3). He obviously wasn't, since in his mind it was already down.

There was another aircraft doing ILSs so we were distracted (No. 4).

At GS intercept, he did not put the gear down (No. 5), and I didn't check as I was trying to locate the other aircraft already on the missed approach (No. 6).

At GUMPS (Gas, Undercarriage, Mixture, Prop, and Speed) time (half-mile out), I didn't check because of concern for a NORDO (No. 7), and luckily I have been doing "flare checks." Just before I commit myself, I have been doing a "three in the green, no red, hydraulics OK, cleared to land" check. That is why we did not land gear up, but why we did scrape the tail skid.

We did use our checklist, but *in his mind*, the gear was down. My excuse was distraction. Needless to say, my procedures have changed. Needless to say, he now also has a flare check over and above GUMPS. . . .

Moral: After GUMPS, still do a *flare check!* It saved two licenses and one airplane. . . .

This is a good example of how a series of mistakes or distractions can set the stage for a mishap. In this case, the mishap was minimal because of a final check which was a habit pattern long used by the IP. Those habitual extra checks may mean the difference between a successful mission and a mishap.

—Adapted from *Callback*, No. 79, Jan 86.

You See . . . There Are Two Meanings Packed Up Into One Word

Humpty Dumpty

We were being vectored for a landing on 27L and maintaining our assigned altitude of 10,000 feet. I was flying and my copilot said, "Cleared to seven." I took this to mean we were cleared to 7,000 feet and started to descend.

At about 9,500 feet, my copilot said we should be at 10,000. I immediately started a climb back to 10,000 and asked him to confirm our assigned altitude with ATC. The controller said we were assigned 10,000 but were now cleared to 7,000.

On thinking back on this incident I believe what my copilot meant was that our assigned runway was TWO seven — NOT that we were cleared TO seven (thousand feet).

To prevent this type of misunderstanding, pilots should guard against abbreviating too much; for instance, if my copilot had said, "Cleared to RUNWAY 27," I would not have misunderstood this to mean "Cleared to seven thousand."

—Courtesy *Callback*, No. 78, Dec 85.

Aborted Abort

An F-4D was No. 2 in a formation takeoff. The aircraft was loaded with two 370-gallon wing tanks, a centerline MER with six BDU-33s, and a TGM-65 on the right inboard pylon. The right afterburner failed to light, and the pilot initiated an abort at 70-80 knots. When he attempted to retard the throttles to idle, both throttles stuck at approximately 90 percent and couldn't be moved in either direction.

With 120-130 knots of airspeed and 5,000 feet of runway remaining, the pilot decided a takeoff would be safer than trying to engage the departure end barrier. He held the nose down until the Phantom had accelerated to 200 knots and lifted off with 1,500 feet of runway left.

The pilot leveled off at approximately 1,300 feet, raised the gear and flaps, and accelerated above 250 knots. By alternately pushing and pulling on the throttles, he was able to free both throttles. The throttles then operated normally for the rest of the flight.

After climbing to altitude, the pilot dumped fuel and talked over the situation with the SOF and a maintenance specialist. They decided the safest course of action would be to make an approach-end barrier engagement in case the throttles should stick again. The landing and barrier engagement were uneventful.

Maintenance impounded the aircraft after it landed. They were able to trace the afterburner failure to a corroded ignition switch. However, extensive inspection failed to reveal the cause of the stuck throttles. They found no indication of binding, scratch marks, or any foreign objects. After a successful test run and FCF, the aircraft was returned to service.

The moral to this story is to be aware of the status of your aircraft. Past, unexplained discrepancies may crop up again when least expected. Check the forms carefully and be prepared. ■

UNITED STATES AIR FORCE

Well Done Award

Presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Mishap Prevention Program.

CAPTAIN

Michael E. Crider

49th Fighter Interceptor Squadron
Griffiss Air Force Base, New York

■ On 9 June 1985, Captain Crider was No. 2 in a flight of two F-106s deploying to Tyndall AFB, Florida. Takeoff and rendezvous with a tanker proceeded normally. Several hookups were accomplished, but Captain Crider's aircraft would not take fuel. Prior to bingo to Tyndall, Captain Crider discontinued efforts to refuel and departed with lead. While climbing to FL 330, he heard the fuselage tank feeding out early, indicating a possible trapped fuel condition. At level off, 150 miles from Tyndall, he noticed an imbalance with the left side fuel tanks reading 500 pounds lower than the right side. The right No. 3 tank, however, was 200 pounds lower than the left. This uncommon coupling of imbalances momentarily masked the critical nature of the situation. After declaring an emergency, Captain Crider continued the climb to FL 410 as he analyzed the situation and tried to get trapped fuel to feed. He decided Tallahassee, 68 miles away, was the closest suitable recovery field. At FL 410, the right No. 3 tank had dropped to 400 pounds. It was now obvious the right No. 3 tank was the only one feeding the engine. Captain Crider made an idle descent from 40 miles out to a 12,000-foot high key for a flameout approach. Contending with thunderstorms in the area and cloud layers from 3,000 feet to FL 180, he executed the approach and broke out of the clouds halfway through the final turn. At three-fourths of a mile on final, engine RPM began decreasing, the main generator dropped off line, and secondary hydraulic pressure dropped as the engine flamed out from fuel starvation. Captain Crider quickly extended the RAT and completed the landing. His accurate analysis, prompt reaction, and superb airmanship saved a valuable aircraft. WELL DONE! ■

☆U.S. GOVERNMENT PRINTING OFFICE: 1986 — 678-032/21037

UNITED STATES AIR FORCE

Well Done Award

Presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Mishap Prevention Program.

CAPTAIN
Joseph Reynes, Jr.

CAPTAIN
Alan J. Vaughn

52d Tactical Fighter Wing

■ On 6 June 1985, Captain Reynes, Pilot, and Captain Vaughn, Weapon Systems Officer, were leading a flight of three F-4Es on a gunnery mission. Ten minutes into the flight, while flying at 450 KCAS and 2,000 feet AGL, the aircraft experienced a hard-over rudder. Captain Reynes engaged the emergency quick release lever, and the rudder began to cycle between full left and right rudder deflection. Captain Vaughn went through each step of the emergency procedures checklist as Captain Reynes pulled the aileron rudder interconnect (ARI) circuit breaker and disengaged the yaw axis stability augmentation. The aircraft momentarily settled down and then both rudder and ailerons began random fluctuations. The chase aircrew observed the rudder deflecting 10 inches from neutral and the ailerons deflecting 6 inches from neutral. Captain Reynes disengaged the pitch and roll axis stability augmentation, but even with the ARI and all stab augs disengaged, the aircraft continued the random flight control fluctuations. After Captain Vaughn ensured all applicable emergency procedure checklist items were complete, Captain Reynes performed a controllability check and found the minimum control airspeed was 230 KCAS. The crew then dumped fuel to reduce the gross weight to the minimum practical for landing. On the first approach at ¼-mile from landing, the aircraft went into a hard-over left 70-degree descending turn. Initially, full right rudder and aileron would not roll out the aircraft. As airspeed increased on the go-around, the aircraft became more controllable; but the violent flight control fluctuations still existed. On the second approach, with Captain Vaughn precisely monitoring airspeed, Captain Reynes was able to land the aircraft. But as the aircraft slowed below 185 KCAS, the rudder drove full left. Both crewmembers were required to hold full right rudder as the aircraft continued to drift toward the left edge of the runway. Captain Reynes also applied full right aileron, careful differential braking (with no antiskid available), and nose gear steering to keep the aircraft from departing the runway surface as it slowed down. Their demonstrated skill, ingenuity, and proficiency, as well as outstanding crew coordination, resulted in the safe recovery of the aircraft. WELL DONE! ■

A Letter From An Old Pilot

To All Flyboys (and Flygirls)

■ I know that each and every one of you is the best pilot since Orville Wright, but remember he killed Tommy Selfridge way back in aught eight and it can happen to you, too. Tell you what; he should have refused his kite. It wasn't within tolerances, and the prop caught and broke off. Made a "purty" big mound of scrap metal. So don't forget to check the rigging and fans and all the "gizmos" you folks have nowadays.

And don't forget to oil the nut that holds the stick aft on takeoff. Consarned thing takes water; can you believe it? A minimum of 3 quarts a day on a hot day! "Yep," hard to believe. You oil it with water and that ain't all; it'll seize up if it don't have salt and po-tassium. It burns a whole bunch of other things too — burns solid fuel you know — can't lean it out too much.

Talk about down time! That fancy stick holder backer's got to have 12 straight hours a day (plus fudge factor for major repairs to boot). And it don't take heat worth a darn. Twenty minutes in the sun and a fellow would be a fool to try to take one of them things up.

Stick holder backers weigh 200 pounds each, and they all got this shell thing that sits on top of 'em. Inside the shell is a little bitty slide rule gadget that tells you when they're gonna pull back on the stick. I think it's the slide rule in there that goes haywire in the heat, or if you don't water or rest it or fuel it up. I never seed one though, cause when one gets busted up in a crash, they just ship the whole "gizmo" (shell and levers and pumps and all) to salvage and get another. Things smell too bad after a crash to want to get too close anyhow.

Seriously, the bottom line is this: The nut behind the stick, the pilot, is *the* most important part of the aircraft system. If the pilot is compromised because of dehydration, heat stress, fatigue, or poor diet, the mission suffers — but the pilot suffers more. We are concerned, your supervisors are concerned, but nobody is more concerned about your safety than you, the pilot. (Nobody can do your pilot-maintenance checklist but you. Remember that!) ■

An Old Pilot