flying

SAFETY

APRIL 1985

CLASS A MISHAPS 1983-1984 — An Analysis

AIR FORCE BIRD HAZARD CONFERENCE

■ The Air Force's Bird/Aircraft Strike Hazard (BASH) Team will host a Bird Hazard Conference at Vandenberg AFB, California from 13-16 May 1985 to discuss all aspects of BASH reduction at military installations. The conference will be open to any member of a base bird hazard working group, or anyone currently dealing with bird problems at a military flying installation. Travel orders will be required for billeting at Vandenberg AFB.

In the past, there have been several forums for discussing bird problems, such as the US Fish and Wildlife Workshop on Wildlife Hazards to Aircraft and the Federal Aviation Administration's Wildlife Hazards to Aircraft Conference and Training Workshop. Although military aspects of bird hazards were discussed briefly at these workshops, there has not been a meeting to deal strictly with the unique considerations of military flying operations. The Bird Hazard Conference will be divided into the following sessions:

▪ **The Bird Hazard Problem** Discussions will focus on why bird hazards exist and how to identify them. The worldwide problem will also be presented including statistics and information from our overseas allies.

▪ **Operations and In-Flight Hazards** Unique bird hazards to military pilots will be reviewed. Suggestions will be made on how to reduce these types of bird risks.

▪ **Airfield Bird Control** An entire day will be spent on this important session because over half of the total strikes incurred are in the airfield environment. Habitat modification, scaring techniques, avian diseases, and hangar problems will be examined in order to aid base personnel in reducing bird hazards.

▪ **Increasing Resistance of Aircraft to Bird Strikes** By designing our aircraft to resist impacts from birds, we can reduce loss and injury. Several "experts" will present current and future design modifications which will aid in withstanding bird strikes.

▪ **New Developments in the Bird Hazard Reduction Problem** What's in the future? The final session will include future methods of reducing bird strikes, such as the role of radar in bird detection.

The conference will conclude with a banquet for conferees and their guests. If interested in attending, contact your MAJCOM/SEF. If there are any questions, please contact a member of the BASH Team at AUTOVON 970-6240/42/43.—HQ AFESC/DEVN, Tyndall AFB FL 32403. ■

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page 8

page 19

page IBC

Special Issue

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AN ANALYSIS OF THE 1983-1984

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Directorate of Aerospace Safety

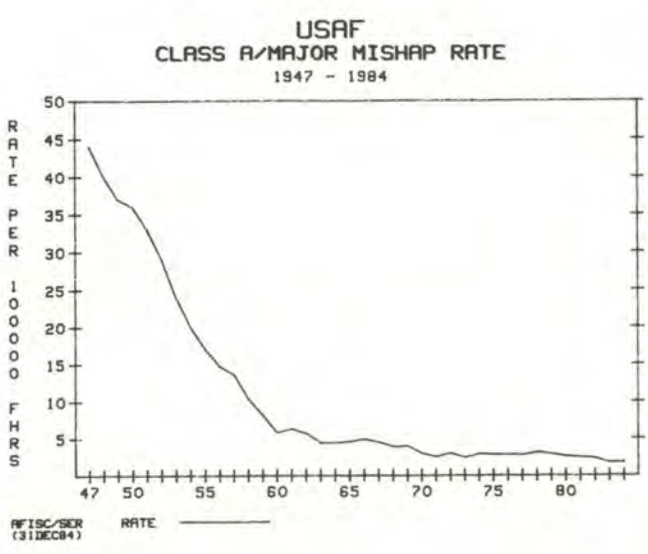
Background

■ The USAF flight Class A mishap rate (Chart 1) showed a dramatic decrease in the 1950s (44 to 8.2), a slight decrease in the 1960s (6.3 to 4.0), and relative stagnation during the 1970s (3.0 to 2.9). In the years since 1979, the Class A mishap rate has resumed its downward trend; however, the decline was slight between 1980 and 1982 (2.57 to 2.33) followed by a sharp drop to 1.73 in 1983, which has continued into 1984 (1.77). This indicates we may have reached a new, lower "threshold" and that any further rate reductions will require major changes or improvements in the way we operate and maintain our aircraft.

The reasons for the rate reductions over our history are far too numerous to describe in detail; however, we have made major improvements in almost every area of our mishap prevention, manpower, and training programs. There is no disputing the fact that we are doing our jobs much more effectively (safely) than we did 10, 20, or 30 years ago.

In spite of these achievements, the increasing costs and capabilities of our newer weapons systems demand that we continue to search for ways to reduce our losses due to mishaps. This analysis will attempt to identify those areas with the greatest potential for improvement.

Chart 1



The automated data bases used included the Air Force Inspection and Safety Center (AFISC) IBM Master Aircraft Mishap File, the Hewlett Packard One-Liner Data Files, the Broad Look Mishap Data File, and the AFISC Individual Flight Record File. Also used were hardcopy mishap reports when necessary to extract data not coded in automated data files. The data used were the 454 USAF aircraft Class A mishaps which occurred from 1 January 1979 through 31 December 1984.

Attempts were made to identify reasons for the reduction in the 1983-84 Class A mishap rate, any similarities or differences between the mishap characteristics of the 1979-82 and 1983-84 time periods, and the significance of any observed differences in these characteristics. Throughout the analysis, observed differences between the variables investigated were tested for significance using a normal distribution test (Z statistic) for trend line slopes and 95-percent confidence intervals.

Discussion

During the 1983-84 time period, the USAF Class A flight mishap rate declined to a new, apparently stable, low of 1.7-1.8 mishaps per 100,000 flying hours. The effect of a Class A lower reporting criteria change from $200,000 to $500,000 starting 1 January 1982 was investigated and found not to have been the cause of the rate reduction which did not begin until 1983. Reduced flying activity is, likewise, not the cause of the lower mishap rate. In fact, flying hours have steadily increased over the past 6 years from 3.1 million to almost 3.5 million hours per year. It is apparent that something not detectable from mishap data has changed in the way we operate and maintain our aircraft, something which has allowed us to do the job more effectively (safely) than ever before in Air Force history.

CLASS A FLIGHT MISHAPS

During the 1979-82 time period, the reduction in the total Class A mishap rate (Chart 2) was due primarily to a decrease in the operations (pilot factor) rate from 2.04 to 1.01, while the logistics (materiel failure) rate held relatively constant around 1.0. The operations mishap types leading the decrease during this period were control losses, collisions with the ground, and takeoff/landing mishaps where the annual mean rates decreased from the .7 and .8 range down to .2 to .3. The differences between 1979-82 and 1983-84 operations rates by mishap type are shown in Figure 1.

The leading operations mishap type — control loss — decreased primarily in the A-7 and F/FB-111 fleets which experienced 12 control losses during 1979-82, and only one since 1982. This decrease testifies to the effectiveness of the automatic maneuvering flap (AMF) and stall inhibitor system (SIS) modifications to those aircraft which were completed in the 1980-82 time frame. The C-135, F-15, C-141, and F-111 total takeoff/landing mishaps decreased from 11 to 0 between the two time periods.

Chart 2

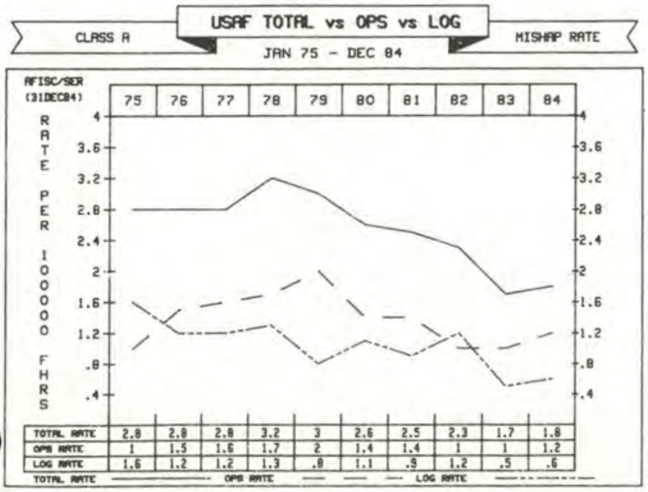


Figure 1

Type Mishap	1979-82	1983-84
Control Loss	.47	.29
Collision w/Ground	.39	.32
Range	.11	.13
Midair Collisions	.12	.16
Takeoff/Landing	.22	.16
Ops Other	.16	.03
Ops Total Rate	1.45	1.08

Since 1982, the situation has reversed, and the total USAF rate decrease has been due to a decrease in the annual logistics rates from 1.22 to .53, while the operations rate has stabilized in the 1.0-1.2 range. The logistics rates by mishap type are shown in Figure 2.

Figure 2

Type Mishap	1979-82	1983-84
Flight Controls	.19	.06
Landing Gear	.09	.03
Fuel System	.12	.06
Engines	.37	.32
Hydraulic/ Pneumatic	.05	.00
Electrical	.05	.01
Structural	.02	.00
Log Other	.12	.04
Log Total	1.08	.53

The greatest quantifiable decreases are in flight controls, landing gear, and fuel system mishaps. The flight control decrease was led by the F-111 (5 to 0); the F-4 (4 to 0); and the A-10, F-15, F-16, F-105, and F-106 (each 2 to 0). The landing gear decrease was due to the C-141 and T-38 (each 2 to 0), while the fuel system decrease was due to the F-4 (6 to 2). All other aircraft experienced 2 or less of these mishaps during either time period. While the overall engine rate has decreased slightly, the F-16 has experienced a significant rate decrease (from 11.19 in 1980 to 1.52 in 1984), while all other aircraft show no significant change in either direction.

On the assumption that the 1983-84 time period represents a new, stable mishap "profile," these mishaps

continued

An Analysis Of The 1983-1984 Class A Flight Mishaps continued

were dissected to identify areas with the greatest potential for return in terms of reducing the overall USAF Class A mishap rate. Of the 121 total 1983-1984 Class A mishaps, 74 (61.2%) were operations (pilot error), 37 (30.6%) were logistics (materiel failure), and 10 (8.3%) were miscellaneous/undetermined. Fighter/attack aircraft accounted for 89 (73.6%) of the total mishaps, 54 (73%) of the operations mishaps, and 26 (70.3%) of the logistics mishaps. Figure 3 shows the mishap distribution by aircraft category.

Figure 3
Type Mishap

Aircraft Category	Operations	Logistics	Misc/ Und
Fighter/Attack	54	26	9
Bomber	2	2	0
Cargo	7	1	0
Trainer	7	4	1
Observation	0	1	0
Helicopter	2	2	0
Other	2	1	0
	74	37	10

It is clear that a given reduction in mishaps would yield the greatest return if applied to fighter/attack aircraft. For example, a 20-percent reduction in the 1983-84 fighter/attack mishaps would have lowered the Air Force total by 18 mishaps and resulted in a combined 1983-84 total Air Force rate of 1.51 instead of 1.75. While the 1984 fighter/attack mishap rate is the lowest in Air Force history at 3.58, it is, nonetheless, in this area that we could reap the greatest rewards. Thirty-one (57.4%) of the 54 fighter/attack mishaps were control losses or collisions with the ground. The aircraft types involved in these mishaps are shown in Figure 4.

Figure 4

Type Aircraft	Control Loss	Collision With The Ground	Total
F-16	0	9	9
F/RF-4	7	2	9
F-15	3	1	4
F-5	2	1	3
F-111	1	2	3
A-10	2	0	2
A-7	0	1	1
Total	15	16	31

It appears that any initiatives or modifications aimed at reducing F/RF-4 control losses and F-16 collisions with the ground would have the greatest impact on our fighter/attack losses. Such things as automatic angle of attack limiters, ground proximity warning systems, improved G suits/connectors, aircrew fitness programs, and increased aircrew awareness of these problems should have a beneficial effect on these types of mishaps.

Another area screened for its "rate-busting" potential was underlying or second level causes. Comparisons were made between 1979-82 and 1983-84 with 1984 data 90-percent complete. Of the mishaps attributed to operations causes, the following areas have shown an increase proportionally in 1983-84: Channelized attention, event proficiency, fatigue, distraction, complacency, and mission stress.

Conversely, decreases have been realized in the following areas: Skill/technique, experience, command and control, inadequate training, discipline breakdown, and task saturation. In the logistics mishaps, causes associated with equipment malfunction, quality control/assurance, and known or repeat problems have increased while inadequate tech data, command and control, and design deficiency problems have decreased. All of these areas, however, require continued or increased emphasis.

A look at the total fighter/attack pilot population since 1979 showed slight decreases in pilots with 500-1,500 hours *total* flying time (31.8% to 27.8%) and slight increases in pilots with less than 500 hours and 1,500-2,000 hours (27.3% to 33.3%). Figure 5 shows the distribution by year and by total flying time.

Figure 5
Total Flying Hours
Percent Of Fighter/Attack Population

Year	0-500	501-1000	1001-1500	1501-2000	2001-2500	2500+
1979	11.3	14.2	17.6	16.0	15.6	25.2
1980	11.0	12.6	18.5	17.0	15.5	25.4
1981	12.0	10.9	18.6	17.8	15.4	25.4
1982	14.3	10.6	17.6	19.0	14.8	25.0
1983	14.0	11.6	16.3	19.3	15.5	23.4
1984	14.2	12.3	15.5	19.1	15.3	23.7

The increase in fighter/attack pilots with less than 500 total hours and the decrease in pilots with 500-1,500 total hours indicates either that retention within this "young" population is not improving, or that these pilots are "experiencing" more slowly due to earlier nonflying assignments. Which phenomenon is causal, if either, could not be determined from data available at AFISC. Figure 6 shows the same pilot distribution based on (UE) (PAA) hours.

Figure 6
U.E. Flying Hours
Percent Of Fighter/Attack Population

Year	0-500	501-1000	1001-1500	1501-2000	2001-2500	2500+
1979	64.0	24.0	4.0	6.0	2.0	0.0
1980	68.0	20.0	8.0	4.0	0.0	0.0
1981	50.0	39.3	3.6	3.6	3.6	0.0
1982	65.2	17.4	4.4	8.7	4.4	0.0
1983	57.7	26.9	11.5	0.0	0.0	3.9
1984	58.6	27.6	10.3	3.5	0.0	0.0

The decrease in the 0-500 hour group is led by a reduction in F/RF-4 pilots in this group (1,223 in 1979 to 642 in 1984). The increases in the 500-1,000 and 1,000-1,500 hour groups are led by A-10 pilots (42 in 1979 to 591 in 1984), F-15 pilots (114 to 485), and F-16 pilots (0 to 369). In spite of building inventories of these aircraft, these increases reflect a slight "experiencing" of their pilots, a factor which should reduce their operations mishap rates.

The total fighter/attack pilot population was compared to the operations mishap pilot population over the 1979-82 and 1983-84 time periods, and differences similar to previous studies were identified. Figure 7 shows the total fighter/attack pilot distribution compared to the operations mishap pilots by total flying time.

Figure 7
Percent Of Fighter/Attack Population

Total Hours	All Pilots 1979-82	All Pilots 1983-84	Mishap Pilots 1979-82	Mishap Pilots 1983-84
0-500	12.2	14.2	12.7	10.9
501-1000	12.0	12.3	15.1	20.0
1001-1500	18.1	15.5	15.9	14.6
1501-2000	17.5	19.1	12.7	20.0
2001-2500	15.3	15.3	29.8	10.9
2501+	25.0	23.7	24.6	23.6

If mishap potential is a function of population distribution, pilots with 500-1,000 total hours appear to have more than "their share" of the operations mishaps (12.3% of the population, 20.0% of the operations mishaps), while all other groups have close to or less than "their share." Two factors that may influence this distribution are: (1) Up to 500 total hours, pilots are generally under increased supervision and flying in relatively structured training programs, and (2) other studies have shown that time in a specific aircraft is a far better reflector of mishap potential than total flying time. To evaluate this hypothesis, the same comparisons were made between the total and mishap populations based on time in a specific aircraft (UE or PAA time) and are shown in Figure 8.

Figure 8
Percent Of Fighter/Attack Population

U.E. Hours	All Pilots 1979-82	All Pilots 1983-84	Mishap Pilots 1979-82	Mishap Pilots 1983-84
0-500	57.4	51.1	61.9	58.2
501-1000	23.1	28.7	25.4	27.3
1001-1500	11.1	12.3	4.8	10.9
1501-2000	5.6	5.6	5.6	1.8
2001-2500	2.3	5.3	2.4	0.0
2500+	1.2	1.5	0.0	1.8

In the case of UE time, the only group that consistently represented a greater percentage of the mishap population than total population was the group with 0-500 UE hours. This is consistent with other experience level studies and further supports the contention that, regardless of total time, exposure to a new aircraft inherently increases the potential for a pilot error mishap.

Still another area investigated was the validity of the causes assigned to the mishaps. Of the 121 1983-84 mishaps, valid causes supported by evidence were found in 79 (65.3%). Of the remaining 42 mishaps, no causes were found for 6, and 36 were assigned causes that were "most probable" or "possible." This indicates that crash survivable flight data recorders would be of value in more accurately determining causes and recommendations for corrective action in 34.7% of the mishaps.

Another area also identified by project Broad Look with potential for reducing ths mishap rate is the time required to implement Class IVA safety modifications. In many cases, procedural, coordination, priority, approval, or funding delays increase the time required to implement a modification. Meanwhile, mishaps the modification is designed to reduce or eliminate continue to occur.

In the case of the F/FB-111 fleet, the SIS modification was first recommended by NASA during wind tunnel spin tests in 1966; however, for various reasons, the modification was not completed until 1981. In the intervening years, 18 F/FB-111s were destroyed due to control loss, and the only F-111 control loss since SIS was installed occurred in one of the few remaining unmodified aircraft. Some progress can be expected in this area, however, as AFISC has the means of projecting losses based on modification lead times and is now in the Class IVA modification loop.

In summary, while we have done well in reducing our mishap rates to their current level, there are still things to be done. Simple awareness of the problems can have an invaluable effect on helping us make further gains. This awareness must be present when decisions are made on priorities, missions, training programs, and during the funding process. We, at AFISC, stand ready to help anyone having trouble selling a modification or program aimed at reducing our losses. Readiness is measured not only by ability, but also by numbers. ■

B-52

MAJOR JAMES R. HUDDLESTON
Directorate of Aerospace Safety

■ Seven hundred and forty-two B-52s have been built since 1955. In the past 29 years, the B-52 fleet has experienced 90 Class A flight mishaps (through the end of 1984). These mishaps have resulted in 71 aircraft destroyed and the loss of 307 lives. The B-52 has amassed 6,550,184 flying hours, resulting in an overall Class A rate of 1.37. The year ended with 165 G and 96 H models still in the active inventory. This article will address the B-52's recent mishap experience, trends, current actions, and modifications, as well as the 1985 forecast.

Mishap Experience

The B-52 exceeded the Air Force Inspection and Safety Center's (AFISC) 1984 mishap forecast. We had predicted 1 Class A and 2 Class Bs; we experienced 2 Class As and 1 Class B, which cost us two lives. The 1984 Class A rate was 1.93, the highest since 1969 and tied with 1974. The 1984 Class B rate was .97. Since 1975, operations and maintenance-related Class A flight mishaps are 5 and 7 respectively. Figure 1 shows the phase of flight and whether it was an operations- or maintenance-related mishap.

Before you Ops types cheer for having fewer mishaps than Mx, you should note that the asterisked mishaps under the maintenance column indicated operations involvement. This means that, although the mishap was caused by maintenance or logistics factors, timely corrective action by the pilot(s) could have either prevented the mishap or mitigated the damage.

Referring to the "engine-start" mishap, a fire resulted because an engine fuel strainer was improperly assembled and installed. A fuel leak resulted following engine start.

Figure 1

B-52 Class A Flight Mishaps (1975-84)

Phase of Flight	Ops	Mx
Engine Start		1*
Takeoff		2
Climb	1	
Cruise		2*
Low Level	3	
Landing	1	2
Total	5	7

* Ops Involvement

The copilot erred when essential DC power was removed prior to the engine fuel shutoff switch closure. Under "cruise," a structural failure mishap occurred due to an uncommanded autopilot input. Operations became involved because neither pilot attempted to disengage the autopilot after the onset of the autopilot input. The third occasion was an engine failure and subsequent separation from the aircraft during cruise. The engine failure resulted from repeated instances of overtemperatures and torching by both maintenance and operations personnel. Operations became further involved because they didn't enter the discrepancies in the AFTO 781 when they occurred.

Note: For all you nonsafety types, a flight mishap is classified as a Class A when (1) an aircraft mishap results in a fatality (or permanent total disability); (2) the aircraft is destroyed; or (3) the total damage cost exceeds $500,000. A Class B mishap is a mishap that results in damage costs between $100,000 and $500,000 or a permanent partial disability. Class C mishaps are mishaps that cost $1,000 to $100,000. High accident potentials (HAPs) are significant hazards to flight crew or aircraft.

For 1984, the B-52 fleet experienced 120 Class Cs. Class C mishaps are important because of the total dollar cost and the trends they may indicate. They are broken out in Figure 2.

In 1984, we were still experiencing bird strikes. Pilots and safety observers: Keep at least one visor down; Crews: Have a plan for bird encounters.

The physiological mishaps varied. Three involved failure to pressurize or loss of pressurization for various reasons, two were fumes in the

Figure 2

Bird Strikes	29	Fuel	4
Physiological	14	Life Support	4
Water Injection	11	Hydraulics	3
Engines	9	Air Frame	3
Weather	7	Landing Gear	2
FOD	7	Pneumatics	2
Extended Takeoffs	6	Flight Controls	1
Dropped Objects	5	Weapons Release System	1
Wheels/Tires/ Brakes	5	Autopilot	1
Electrical	5	Deer Strike	1

cockpit, and two crewmembers flew with colds. The others were isolated although interesting: One case each of getting fire extinguisher agent in the face, poor nutrition, hyperventilation, and a rapid decompression (RD). The RD occurred because of a corroded cannon plug in the left forward main landing gear crosswind crab squat switch.

The water injection problem is being worked with the engine fuel control units' microswitches and circuitry being suspect. The engine mishaps did not reflect any trends. Two were starter malfunctions, and two were fuel related. The other five were unrelated.

The five weather-related mishaps were the result of static electricity. Flying in light precipitation and within 10-degrees of the freezing level is conducive to static discharges. If the mission will allow, avoid this area by climbing, descending, or altering the route of flight.

FODs in 1984 didn't provide much in the way of trends since most were undetermined. One FOD occurred when a taxiing B-52's jet blast blew debris into another B-52's engine.

The extended takeoff roll problem appears to have been resolved. Oversized brake rotor segments and malfunctioning hydraulic pressure relief valves were felt to have caused the problem.

Current Safety Mods

There are currently two safety modifications that are funded and in progress. A third, the upgraded autopilot, is planned and partially funded.

- TCTO 1B-52G-785 changes the engine water injection system electrical circuitry. This modification deactivates both engines in a pod if one of the throttles in that pod is reduced. Additionally, it prevents water reinitiation on that pod. Ninety-seven percent of the G models have received the mod.
- TCTO 1B-52-2372 will replace the fuel hose between the forward body and center wing tanks. The new hose will be fire resistant and less susceptible to the chimney effect of a forward wheel well fire. Oklahoma City Air Logistics Center is awaiting parts from the contractor. Once the parts are received and kit-proofed, the field-level mod should be completed in four months.
- TCTO 1B-522-2378, when fully funded, will upgrade the autopilot. Air Force Inspection and Safety Center's special autopilot reports have resulted in 723 reported autopilot malfunctions for the July-December 1984 period. This should help expedite the funding.

Other Ongoing Modifications*

- TCTO 1B-52-2255 replaces the centering and squat switches on the right forward, right aft, and left forward main landing gear. Sixty-eight percent of the aircraft are modified, leaving 85. The estimated completion date is January 1986.
- TCTO 1B-52-2309 and 2310 will replace the existing air conditioner pack with a unit of larger capacity. Programmed depot maintenance has just started this fleet modification; it is scheduled for completion in October 1989.

To provide new or improved operational capability is part of the definition of a Class V modification; two will be addressed.

- TCTO 1B-52-2252 provides for external cruise missile launch capability. Fifty percent of the affected aircraft are completed. This modification applies to two-thirds of the G and all of the H models.
- TCTO 1B-52-2253 incorporates the offensive avionics system through replacement of most of the bomb-nav system with state-of-the-art digital equipment. Currently, 59 percent of the aircraft have received the modification.

*Mission essential mods, some of which are safety related and are worthy of mention.

The Future

Reviewing the B-52's mishap history, 1 Class A and 2 Class B flight mishaps are predicted for 1985. The Class A will be a collision with the ground. One Class B will be a bird strike, and the second Class B will be engine related.

The forecast reflects the way we support, maintain, and operate our aircraft. It is based on three assumptions: (1) That we have accurately defined the type of mishaps our aircraft are likely to have; (2) that we have accurately assessed current trends; and (3) that nothing changes in the way we support, maintain, or operate our aircraft in terms of policy, procedures, tactics, etc. The forecast also presumes that the B-52s will fly 102,983 hours in 1985. Unfortunately, all too frequently, AFISC mishap forecasts are accurate.

You can prove our forecasts wrong. You've done it in the past; you can do it again. The Air Force's goal is to reduce mishaps. This year, let's reduce B-52 Class As to zero. ■

C-5

MAJOR JAMES C. PARRY
Directorate of Aerospace Safety

■ As "Ship 82," the first new C-5 in 15 years and the first "B model," prepares for its debut this summer, the C-5A can look back and bask in its remarkable safety record — 8 of its 17 years with no Class A mishaps and only 1 mishap in 17 years with fatalities. In 1984, all 77 C-5As that started the year completed the year without a Class A mishap. Thirty-four aircraft now have the big wing and are flying the mission this heavy airlifter was designed to accomplish.

The only two Class B mishaps the C-5 experienced in 1984 were in the area of the engine. The first occurred on climb out: A hydraulic line on the Number 4 engine failed, and an explosion blew off the cowl doors. The aircraft made an uneventful return to home station. The hydraulic lines are now being tested prior to installation and new procedures employed to make the hoses stronger.

Figure 1
C-5 Flight Mishaps (1979-1984)

	A	B	C	HAPs	Total
1979	0	2	26	21	49
1980	1	3	26	23	53
1981	0	1	20	15	36
1982	1	2	31	14	48
1983	2	2	28	18	50
1984	0	2	24	14	40

The second Class B occurred when, on departure, the Number 1 engine exploded — but for a different reason. Like two earlier engine problems in 1984, components in the compressor case failed allowing the compressor case to shift and come apart at a high power setting. The crew landed the aircraft uneventfully, and the engine fire was extinguished by the base fire department. The emergency escape slides in the troop compartment deployed. One did not get inflated in time to be used, and all passengers exited using the other slide. All C-5 engines have been inspected and new parts will be installed in the compressor area.

As a sidelight, recent tests of the emergency escape slide systems at Travis illuminated inconsistencies in the installation of the slides. Efforts to correct these are underway.

The outstanding record of no Class A mishaps in 1984 brings the lifetime C-5 Class A mishap rate (number of mishaps per 100,000 flying hours) to 1.75. The Class B rate for 1984 was 3.48, and the overall rate was 2.91. While this is not as good as the C-141, it is below the Air Force rate for last year, and our record of only one fatal mishap is unmatched in the Air Force.

Figure 2
Types of Mishaps (1982 to 1984)

	1982	1983	1984
Logistics	31½	29	27½
Engines	13	2	4
Landing Gear	13½	13	9
Slats	2	4	0
Other	3	10	14½
Operations	2½	5	½
Taxi	1	2	0
Miscellaneous	1½	3	½
Other	14	16	12
Bird Strikes	10	5	5
Cargo Spills	2	6	2
Physiological	2	2	2
Miscellaneous	0	3	3

Logistics Mishaps

While the number of logistics-related mishaps continues to show a steady decline, it is not going down as fast as we would wish. Even though the number of TF39 engine problems is lower and gear mishaps are down, the other logistics category is growing by leaps and bounds.

Early on, an engine fire due to an old style roller bearing occurred. Later a Class C mishap engine fire occurred on takeoff from a CONUS base. That mishap was the precursor of the Class B mishap. The fourth engine problem was a two-engine shutdown on engine start at Ramstein, one due to fuel venting and another engine for excessive fuel flow. The other Class B mishap, the hydraulic line failure, as well as another two-engine shutdown for oil loss, fell into the "other" category since they weren't strictly engine related.

Landing gear mishaps decreased. Only three of them were 82-degree gear box (Pacer Pup modified) failures, which is much better than last year. The other six include three nose landing gear problems, which will hopefully be corrected by the new modification making the gear doors single drive actuated; a main landing gear actuator failure; an idle arm failure; and a main landing gear that apparently does not like its rigging and repeatedly likes to hang up on retraction (that same aircraft had two mishaps in 1983). With no slat problems to report this year, we go on to the "other" category.

It may seem strange to have 14 and one-half mishaps, but I think you'll see why. Three times in 1984, nose landing gear wheels departed the aircraft on takeoff — it seems that maintenance procedures need to be modified to make this operation more fail-safe. The air conditioning system put out smoke and fumes once due to a malfunctioning cooling air door. The ailerons were binding on one aircraft due to a bad cotter pin installation. A CDPIR deployed due to bad installation. One C-5 did the shimmy in flight when a yaw augmentation system burped, but since there was no Material Deficiency Report submitted, the real cause could not be found. An engine fire bottle malfunction at an overseas location is still under investigation. A rejected takeoff due to a suspected rudder problem resulted in blown tires due to a malfunctioning antiskid. A shorted relay caused some more smoke and fumes in the cabin (it pays to know how to use your oxygen systems). Another dual engine shutdown occurred when maintenance failed to install the proper gaskets on one engine change, and the other engine wasn't written up properly for excessive oil consumption — result, two engines shut down. An overseas location made an improper repair to a hole in the sheet metal so that when the crew returned to home station, a large portion of the aileron hinge area was missing.

Another mishap that raised a great deal of concern was an engine fire as a result of a generator CSD that wouldn't disconnect when the generator failed. The reason for the concern was that, again, the emergency escape slides in the troop compartment failed to deploy automatically.

And lastly is the one-half logistics mishap and the one-half operator error mishap. The automatic cabin altitude controller failed after departure. The crew maintained pressurization using manual. Later, the crew reattempted to use the failed automatic controller, and the aircraft experienced a rapid decompression. After descending, the crew regained control of the pressurization, climbed back to altitude, and landed uneventfully with no passenger or crew injuries.

Operations-Related Mishaps

The last mishap under the logistics category covers the half a mishap in the operations area. After 1983's two Class A mishaps in the operations area, it is great to see this kind of performance from the crews. Hope that it can stay this quiet in 1985.

Other Mishaps

Bird strikes, physiological, and the dreaded "other" category are about the same as last year. Cargo spills are being reported differently this year, so the number of these has decreased. The bird strikes were shared between Dover, Travis, and Altus. Two passengers passed out, both coming back from overseas. The cargo leaks were compliments of the Army (a helicopter) and the Navy (cleaning compound).

The three in the "miscellaneous" category were all FODDED engines. One was from a fan stopper that came apart, the second was source and item unknown, and the third appears to be a piece of the cowling that came off in flight and was digested through the engine.

1985 Forecast

The prediction for 1985 is more of the same — a Class A landing problem, a Class B engine problem, and a Class B bird strike. The outstanding success achieved in 1984 (with no Class A mishaps and almost no operations-related mishaps) is an enviable goal for us to attain. Just keep up your highly professional efforts, and the C-5, with new wings and both A/B models, will continue its remarkable safety record. ■

C-9

MAJOR DOUGLAS J. MILLER
Directorate of Aerospace Safety

■The USAF fleet of C-9s accomplished another year free of any Class A or B mishaps in 1984. In over 400,000 hours of operations with the Air Force, the C-9 fleet has only experienced 2 Class As and 1 Class B mishap. Crew members, supervisors, and maintenance personnel have good reason to be proud of their professional efforts which have resulted in this record.

The three C-9C special air mission aircraft had no reportable Class C or HAP mishaps in 1984. The C-9A aeromedical evacuation aircraft experienced 7 Class C and 1 HAP mishaps in 1984. These mishaps included an engine rollback, 2 tire failures, a birdstrike, a FOD mishap, a false fire warning indication, a physiological episode, and a failure of an anti-ice tee-duct.

The false fire warning indication mishap is worth reviewing in that it shows how an operator error combined with a material malfunction can result in a serious situation. The pilot, who was receiving IP upgrade training, had put the engine fire detection system in "loop B" rather than the normal "both" position, planning to simulate a fire in the Number 2 engine. With the switch in this position, a loop malfunction could produce a fire indication. In accordance with Murphy's Law, that is exactly what happened. Had the pilot repositioned the switch back to the "both" position, the shutdown of a good engine could have been prevented. Good systems and procedural knowledge enhance safe operations.

Another mishap with serious implications was the material failure of an airfoil anti-ice tee-duct which interfered with slat operation. Initial indication of the problem appeared in the cockpit as a pneumatic leak or imbalance in the airfoil anti-ice ducting. Initial inspection did not reveal damage, and since anti-icing was not required for the mission, the crew elected to continue. During taxi to parking on the following sortie, the severed tee-duct prevented slat retraction on one side of the aircraft. If the aircraft had been required to make a go around with split slats, it is likely that a major mishap would have occurred. Tee-ducts are now being inspected more frequently.

C-9s were involved in seven hazardous air traffic reports (HATR) in 1984. This is not surprising considering the multiple sortie missions and operations into fields which have high density traffic situations. It does, however, identify the need for a high state of vigilance in areas such as clearing and close monitoring of aircraft radios.

In the area of safety modifications, the C-9 is close to receiving strobe lights. The mod has been approved by AFLC and is awaiting Air Force approval. Strobe lights will decrease the C-9's midair collision potential.

The C-9 air evac and the C-9C SAM are both difficult missions. The motivation to accomplish many urgent missions is strong. However, the tendency to "press" weather and other limitations must be avoided in order to accomplish the mission safely.

C-9 operators and maintainers have much to be proud of. With the type of commitment made in 1984, we can continue to keep the C-9 safety record outstanding in 1985. ■

C-130

MAJOR DOUGLAS J. MILLER
Directorate of Aerospace Safety

■ The C-130 operators and maintainers produced a good safety record in 1984 while accomplishing many difficult missions. Approximately 372,000 hours were logged in 1984 which brought the total for the Air Force C-130s to over 10,000,000 flying hours.

In this article, I will present some of the lessons learned from the mishaps which occurred in C-130s in 1984. We'll also look at some trends and other safety issues those of us face in the C-130 business.

There were three Class A mishaps in 1984. The most tragic in terms of loss of life was a C-130 that impacted rising terrain while practicing adverse weather aerial delivery system (AWADS) in marginal weather. Nine crewmembers and nine passengers were killed in this crash. Another C-130 was destroyed when it departed the runway after an actual engine-out landing. The third Class A mishap occurred when the landing gear collapsed, and touchdown took place too far down the runway for a safe landing. All of these major mishaps were ops related!

There was only one Class B mishap in 1984. An uncontained turbine failure resulted when a "thin rim" turbine spacer failed. This design deficiency is being corrected when engines receive depot maintenance. Operating limitations have been recommended for engines which have not been modified with the "thick rim" spacers.

C-130 Class C and HAP mishaps decreased from 269 in 1983 to 248 in 1984.

Increases in bird strikes, lightning strikes, and flight control mishaps suggest that we must devote more attention to these problems. Increased low altitude training is one possible explanation for the increase in C-130 bird strikes. Since in most cases we can't get birds to avoid us, we need to stay aware and clear of areas of high bird concentrations. Continued thorough reporting of bird strikes, whether or not they cause damage, will assist in this effort.

To reduce the potential for lightning strikes, the importance of giving thunderstorms a wide berth cannot be overemphasized. Most C-130 lightning strike incidents in 1984 did not occur while flying through cells, but while operating in areas where thunderstorms had been forecast.

The frequency of flight control mishaps is increasing and caused

continued

C-130 Mishap Summary

	1984	1983
Class As	3	1
Rate/100,000 flight hours	.8	.3
Destroyed	2	1
Fatalities	18	6
Class Bs	1	1
Rate/100,000 flight hours	.3	.3
Class Cs and HAPs	248	269
Rate/100,000 flight hours	66	72
Birdstrikes	31	21
FOD	25	30
Lightning	20	17
Flight control mishaps	19	12
Two engine shutdown	9	15
Dropped objects	6	8
Cargo leaks	3	6
Inadvertent liferaft deployments	0	3

C-130 continued

some of our most serious HAP and Class C mishaps in 1984. Unfortunately, as our aircraft get older, we can expect more of these problems. We can prevent some through detailed 781 writeups and thorough maintenance investigation and inspections whenever unusual forces are felt in the controls.

A loadmaster was injured when an uncommanded elevator trim actuation took place. This was only one of several mishaps in 1984 where crewmembers were injured, most often during normal flight operations. Care while moving around the cargo compartment in flight, as well as warnings from the flight deck prior to maneuvering the aircraft, will minimize these risks.

On the positive side, FOD mishaps, two engine shutdowns, dropped objects, cargo leaks, and inadvertent liferaft deployments all decreased in 1984. Through the continued superb efforts of all maintainers and operators, we know you can continue these trends in 1985.

There are some valuable lessons to be learned from mishaps which occurred in 1984 to prevent the recurrence of unfortunate events. Inadequate mission planning was a major factor in 1984. Converting a VFR route to an AWADS route without accounting for the differences in radius of turn helped set up a situation where flying "on course" put the C-130 in the path of the rising terrain. An early descent and slowdown to adjust time over target and a more rapid-than-prescribed descent rate (a normal practice for the crew at their home base due to altitude restrictions on their AWADS training routes) put them *into* rather than *over* the mesa.

There were also problems with map coordinates and definitions of mountainous terrain on the charts. Furthermore, putting an inexperienced navigator and copilot on the same crew and having them fly the mission in marginal weather was a questionable decision. Though there was an instructor navigator and instructor pilot on board, they were not the same ones who had flown the route in VFR conditions the night before. The rising terrain had been noted on that previous flight, but only as reference to the DZ and not as a hazard.

The many contributing factors in this mishap show that a disaster can develop through the compounding of many, seemingly small, errors. Increased supervisory emphasis has been placed on thorough mission planning and route/map study.

Another problem common to at least two of our serious mishaps in 1984 could be called "pressing." Why did a highly qualified C-130 pilot land his aircraft with less than 2,000 feet of runway remaining? Why would another crew try to "feel their way" down through fog into a VFR assault zone to the point where they impacted trees? The urge to complete a mission is often strong, but it must be tempered with the realization that if conditions are outside of established limits, the effort must be discontinued. Ducking below minimums to land from an approach not only subjects the crew to unwarranted danger but gives them the false sense that they can get away with it on a regular basis.

Breakdowns in crew coordination were another problem which surfaced in several mishaps. In one of our mishaps, the crew was named as a factor because they said nothing to the pilot when it was apparent that a safe landing was no longer possible. The advantages of the crew concept are negated when crewmembers do not speak up when they observe an unsafe situation.

Turning to the safety aspects of the C-130 airframe, the overall situation is improving. Rehab of the center wing on C-130A and the new outer wing for C-130B and E models is well underway and will make that part of the aircraft structurally sound far into the future. Warner Robins ALC's Damage and Durability Testing Assessment Office runs continuous testing on C-130 airframe structures to repair or replace components which suffer from fatigue.

Installation of explosion-proof foam in fuel tanks has made the C-130 less susceptible to the hazards of lightning. The problem of foam fires has decreased with the installation of impingement cages and more conductive yellow foam. There were only six reported foam fires in 1984 which is an improvement over recent years. Be aware, though, that the problem remains. Maneuvering flight in a low humidity, low temperature environment is more conducive to this problem. Forewarned is forearmed.

There are other significant safety modifications underway. Installation of cockpit voice recorders and flight data recorders will make "unknown cause" mishaps much less frequent and therefore mishap investigation/prevention more effective. Strobe lights for the C-130 have been approved and will be installed once adequate shielding is developed to protect the compass system.

Increased mission requirements and lower experience levels of both aircrew and maintenance personnel seem to be common denominators throughout the C-130 fleet. This situation demands a high level of safety consciousness in all of us, particularly supervisors, in the C-130 business. If we all make a commitment to doing our best, safely, 1985 can be a better year. ■

C/KC-135

MAJOR RAY GORDON
Directorate of Aerospace Safety

■ In 1984, the C/KC-135 completed its 29th year of service — still going strong after flying over eight million hours. The year was highlighted with another Class A mishap-free record. We have equaled this accomplishment in only three other years: 1957, 1978, and 1983. However, in February 1985, an RC-135 was lost near Valdez, Alaska, while practicing instrument approaches. At this writing (the first part of March), the investigation continues. The last two mishaps prior to this occurred in March 1982.

Many individuals and organizations are responsible for this long mishap-free period of almost three years — aircrews, maintainers, supervisors, logisticians. The Air Force Inspection and Safety Center salutes your dedication to the safety of the fleet.

Although the mishap trend is down, the age of the fleet poses legitimate safety concerns. The 744 aircraft fly approximately 260,000 hours per year. The average time on the fleet is approximately 11,000 hours. Aircraft fatigue, corrosion, brittle electrical wiring insulation, spurious autopilot inputs, fuel cell problems, and engine fatigue all have age as the common denominator.

There were three Class B mishaps in 1984. The first mishap was an uncontained engine failure caused by a cracked J57-59W third-stage compressor blade. Since the failure, other third-stage blades have failed, and the trend has prompted action to reblade the compressor with new third, fourth, seventh, and eighth stage blades. Although current actions are dealing with the problem as fast as possible, we project five additional engine failures before the reblade program is completed in FY 89.

The second Class B mishap was an engine cowling fire after takeoff, caused by fuel from an undetermined source igniting on the hot turbine case, and sustained by burned-through fuel and oil lines. TCTOs are currently in effect to provide drain holes in the lower cowling area and to modify the fuel strainer cap.

The third Class B was a failure of a reworked main landing gear trunnion collar bolt during a hard landing. When the left main gear would not indicate a positive gear down indication, a planned crash landing was made, and damage occurred when the gear collapsed. New trunnion collar bolts are being produced to replace the reworked bolts by December 1985. Until then, interim measures have restricted heavyweight landings.

A look at 1984 Class C mishap information reveals some differences from previous years. The number of Class Cs and HAPs is down a significant 23 percent from last year, continuing a downward trend. In 1982, there were 167 reports; in 1983 there were 145; last year there were 111. Significant improvements are evident from last year's top four causes of C/KC-135 mishaps.

	1983	1984
Air Refueling	40	29
Birdstrike	21	23
Physiological	16	8
FOD	14	3

Although air refueling mishaps have decreased significantly, there is still room for improvement. Of the 40 mishaps experienced in 1983, 26 were caused by pilot/boom operator error (operations mishap), and 14 were caused by an air refueling system malfunction (logistics mishap). In 1984, the ratio was similar with 20 operations-related to 9 logistics-related mishaps. How does your training program stand up to the test? Meanwhile, efforts are underway to improve both the boom and drogue air refueling systems. (For more information on air refueling mishaps, see the article on page 25 of this issue.)

Congratulations are also in order for the significant decrease in physiological and FOD mishaps. Your efforts in reducing these mishaps are well worthwhile. Your efforts in the base's bird strike program can also achieve similar decreases. I've seen it work; how strong is yours?

Now let's look at some other Class C categories with significant decreases or increases.

	1983	1984
Lightning	12	2
Engines	8	10
Crew Error	3	7
FOD	4	0
Flight Controls	4	0

In 1983, the increase in lightning/static discharge mishaps to 12 was unexplainable other than crews flying too close to thunderstorms. Last year's jump back to 2 mishaps may mean better radar maintenance or weather avoidance training, a.k.a. better supervision.

Last year's engine-related Class C reports show an increase in both J57 compressor and turbine failures. As stated earlier, we know that there will be at least five J57 third-stage failures before we complete the reblade program. Until then, make sure you are mentally prepared for an engine failure during a critical phase of flight.

One of the most disturbing increases is in the crew error category. In the 1983 mishaps, one crew scraped a boom and another an engine due to improper landing techniques; yet another installed an aft hatch improperly.

In 1984, other more imaginative errors surfaced: One crew almost didn't stop in the runway available due to a combination of judgment errors; two crews attempted braking from the right seat (the one *without* antiskid); another crew flamed out a pair of engines from fuel starvation; still another crew found out that using too much power to taxi can blow down guard shacks and ground crewmembers; and another crew learned that trying to transfer hydraulic fluid between systems by using the pilot's brakes can cause brake failure on landing.

The key to preventing crew error mishaps is knowing aircraft systems and adhering to TO procedures and regulations.

Since 1975, 15 Class A flight mishaps have occurred. During this period, only 2 were attributed to logistics-related problems; 12 were operations-related; and 1 is still under investigation. For 1985, the Air Force forecasts 40 operations and 20 logistics mishaps. With this forecast, 2-to-1 ops/log ratio and the C/KC-135's 6-to-1 historical ratio, it's not hard to see where our emphasis should be to prevent the next Class A mishap. What can be done to alleviate the risk?

In the short-term, there are things unit supervisors can do. First, don't give "lipservice" to safety. A commander must "live" safety — lead by getting involved with crews, maintenance, and support organizations. Let them know exactly where you stand on the issues. Anticipate. Look for and accept nothing less than the best from all.

Secondly, actively educate aircrew and maintenance personnel to the causes of mishaps and the lessons learned.

Thirdly, exemplify and support physical conditioning programs. This is an excellent means of combating fatigue which has cropped up as a second-level cause in many mishaps. Fatigue causes judgment errors, distraction, channelized attention, and a subtle erosion of performance along with the ability to recognize it.

In the long-term, Air Force safety issues need to be resolved. Some safety issues currently being addressed are the reengining programs and the solid-state autopilot modification which will make significant improvements to the safety of the fleet. In other areas, we need to support acquisition of a ground proximity warning system and a strobe light system. We also must apply the lessons learned from civilian and military tragedies to realistically respond to the hazards of toxic smoke and fumes for crew *and* passengers, and to acquire protective equipment to sustain life in this hazardous environment.

The mishap forecast of one mishap, unfortunately, has already come true. But, this should not discourage our efforts to sustain what has been an outstanding mishap record. It will take hard work, but we can meet the challenge. ■

KC-10

MAJOR RAY GORDON
Directorate of Aerospace Safety

■ At the end of 1984, the KC-10 fleet had completed its fourth year of tanker/cargo service, logging a total of 41,437 lifetime flying hours without a Class A mishap. Last year, 19,534 hours were flown as the fleet continued to grow. Presently, 29 of the projected 60 aircraft are operating from Barksdale and March Air Force Bases, with Seymour-Johnson scheduled to become the third main operating base in FY 87.

In 1984, the KC-10 experienced its first Class B mishap when a bolt from an unknown source damaged a tail-mounted engine. Commercial DC-10s have experienced similar occurrences.

Eight Class C mishaps occurred last year; 5 involved air refueling systems. Of the 2 drogue-related mishaps, 1 was caused by a broken ground wire which resulted in severe hose oscillations and drogue separation. The other was drogue damage discovered after a Navy A-6 pilot had some control difficulty. Two other drogue-related mishaps involved Navy/Marine receivers. One was damage to an F-18 AOA vane, and the other was an incompatibility problem between the AV-8 probe nozzle and the drogue coupler.

Of the 3 boom-related mishaps, 1 occurred when a boom hoist cable bolt broke, and the crew could not secure the boom prior to landing. Another occurred when a student F-4 pilot failed to visually confirm a disconnect, and a brute force separation damaged the nozzle. The last mishap was a KC-135 boom nozzle separation due to an unstable KC-10 receiver pilot. (For more information on air refueling mishaps, see the article on page 25 of this issue.) The last 3 Class C mishaps were all engine-related. One was another FOD damage, 1 was a bird strike, and 1 was turbine damage caused by a leaking eighth stage bleed duct.

The most serious mishap, however, was not charged to the KC-10. A Marine A-4 was lost when the hose reel takeup system failed, and the resulting hose oscillation broke the hose, spilling fuel into the A-4's engine. The A-4 suffered a series of engine explosions; the pilot ejected and was recovered safely. The cause of the takeup system failure is still undetermined, but the system program office and McDonnell-Douglas are conducting a comprehensive study of the hose reel system to determine several near and long term improvements, which may include modifications to the takeup rate capability and to the hose exit tube angle.

Although there are no Class A mishaps forecast for the KC-10 in 1985, an operations-related mishap could occur. As the global mission of the KC-10 increases, the necessity of using sometimes austere forward operating locations also increases. Because the reins of supervisory control may be limited, greater decisionmaking responsibilities rest on the crew. Recent mishaps in other weapons systems have highlighted crew mistakes in a tragic way. The KC-10 crew force must continue to strive for professionalism and excellence in order to maintain their excellent safety record. ■

HELICOPTERS

MAJOR ANTHONY J. ROGET
Directorate of Aerospace Safety

■ The 1984 helicopter mishap record, unfortunately, did not match the excellent record set in 1983. The Air Force as a whole experienced 4 Class A mishaps and 2 Class B mishaps. A total of 16 people lost their lives in these mishaps. Figure 1 shows the 1984 mishap experience by category.

Figure 1
Class of Mishap

	A	B	C	HAP
H-1	1	2	23	13
H-3	1	0	14	12
H-53	2	0	15	10
H-60	0	0	4	2
Total	4	2	56	37

A UH-1N was lost early in the year while returning from an operational drug enforcement mission. The aircraft was over water at night when it crashed in the ocean. Five lives were lost in this mishap.

An H-3 supporting a Trident missile launch at night crashed into the ocean and was lost. Three crewmembers and two passengers were not recovered.

Two H-53s were lost near the end of the year. The first crashed into a mountain while on a night, low level training mission. All six crewmembers were fatally injured in this mishap.

The second H-53 was lost when the tail rotor gear box separated in flight. Although the aircraft was successfully autorotated to a suitable area, the aircraft was damaged beyond economical repair during the landing.

Both Class B mishaps involved H-1s. The first was damaged when it struck the ground during a practice autorotation. The second resulted when the helicopter developed severe vibrations in flight. As the pilot attempted to land in a congested downtown area, the main rotor blades struck a pole, and the helicopter crashed on its side.

In addition to these mishaps, there were a total of 56 Class C mishaps reported and 37 HAP mishaps. Figure 2 breaks these mishaps down further.

Figure 2
Class C and HAP Mishaps

	H-1	H-3	H-53	H-60
Hydraulics	0	2	2	0
Flt Controls	0	4	3	0
Engines	11	9	5	1
Drive System	8	2	2	1
Fuel System	5	0	0	0
Aircrew	3	1	0	0
FOD	3	2	3	0
Misc	6	6	10	4
Total	36	26	25	6

H-1

As in past years, the Huey fleet had the largest share of Class Cs and HAPs. The largest single problem area was engines with 11 mishaps reported. These ranged from power losses to actual in-flight engine failures. Problems with the drive system were second with mast bearing failures leading the list. The aircrew mishaps included a wire strike and a tree strike.

H-3

Engines were the number one problem area in the H-3 fleet also. Most involved engine failures. Uncommanded flight control inputs were next with four reported.

H-53

The engine problems in the H-53 did not include any actual engine failures but did include several precautionary shutdowns. Two of the miscellaneous mishaps involved tail pylon hinge fitting cracks, a problem that is being worked by Warner Robins ALC. Only one main rotor blade pocket separation was reported, a significant improvement over 1983.

H-60

Six H-60 mishaps were reported in 1984. These included an engine flameout, an uncommanded cargo hook release, a transmission chip light, a crewmember injury, and two physiological episodes.

All in all, 1984 was not a good year for Air Force helicopters. Commit yourself now to making 1985 a safer year for helicopter operations. ■

Figure 1
C-141 Flight Mishaps (1979-1984)

	A	B	C	HAPs	Total
1979	3	4	90	103	200
1980	1	0	109	123	233
1981	1	1	73	66	141
1982	1	0	66	74	141
1983	0	2	77	73	152
1984	1	0	73	49	123

Figure 2
Mishap Comparison

	1981	1982	1983	1984
Logistics	76	66	53	60
Flight Controls	37	18	13	13
Landing Gear	24	10	18	7
Hatch			3	4
Engine				4
Tires				13
Brakes				5
Misc (no trend)	11	22	19	14
Operations	15	13	23	18
Taxi Mishaps	5	1	3	1
Air Refueling	4	2	3	2
Belly Scrape	3	2	8	1
Misc (no trend)	3	9	7	14
Other	50	68	76	45
Cargo Spills	19	29	31	5
Birdstrikes	15	20	25	15
Engine FOD	7	8	10	8
Physiological	7	6	2	5
Misc (no trend)	2	5	8	12

C-141

MAJOR JAMES C. PARRY
Directorate of Aerospace Safety

■ In 1984, the C-141 fleet had good news to cheer about and some bad news to worry about. The good news is that the number of mishaps has decreased from the predictable average of 150 down to a new all-time low of 123 (Figures 1 and 2). The bad news was that this was largely due to a change in mishap reporting requirements. Additionally, after an impeccable 1983 with no Class A mishaps, 1 C-141 and its crew crashed shortly after takeoff, fatally injuring all on board. In the meantime, the C-141 continues its unquestionably unsurpassed leading role as the strategic/tactical airlifter of the year — a plane for all seasons.

The mishap of the year was undoubtedly the Class A that occurred shortly after takeoff. As the heavy C-141B took off from an overseas station, an engine failure resulted in shrapnel penetrating the cargo compartment and starting an onboard fire. Within 3 minutes and 18 seconds from the start of takeoff roll, the aircraft impacted the terrain and was destroyed. The primary elements that led to this mishap are being addressed, with new equipment and procedures forthcoming. The Air Force Inspection and Safety Center will continue to strive to enhance the onboard fire suppression/fighting capability for cargo/tanker aircraft in hopes of preventing similar type mishaps.

Two other mishaps in 1984 started out as Class B mishaps ($100,000 to $500,000). One was the loss of a pedal door in flight during an air drop exercise mission. Discovery of all the pieces (the door broke in half) and some expert repair capability by the folks at Warner Robins ALC managed to bring the cost down to below $100,000.

The second mishap was an engine cowling that decided to come off shortly after takeoff. The crew didn't have any indication of the magnitude of their problem and its serious potential consequences until they discovered they couldn't pressurize. After an uneventful landing and upon inspection, they found the cowling missing. Again, the primary parts were located, and the cost to repair the broken cowl was below $100,000.

The C-141 still remains the unparalled leader with a remarkable safety record of only 0.39 mishaps per 100,000 flying hours (C-5 = 1.75; C-130 = 1.27). The Class B rate remains low at 0.28. The good news in the reduction of Class C/high accident potential mishaps from the previous years' records was largely due to the change in reporting requirements for cargo spills. A quick look at Figure 2 will show 26 fewer cargo spills than last year which closely corresponds to the drop in mishaps.

Logistics Mishaps

Logistics mishaps, having to do with design, procurement, maintenance, handling, or modification of the aircraft, remained steady over the course of the year. Flight-control related mishaps stayed the same as 1983 and landing-gear related mishaps decreased. But Number 2 hatch, engine, tire, and brake problems all increased.

Flight control mishaps continue to

cause concern to all who fly. New components have alleviated many of the old problems, but some still seem to crop up requiring the professional airmanship of our crews to solve. We still need to stay on top of these problems to get permanent fixes to this 21-year old system.

Landing gear problems are decreasing, but unfortunately the tires and brake/antiskid components are causing increased headaches and reports. Early in the year, main landing gear tire failures suddenly surfaced. The logistics centers feel it was due to underinflation of the tires. Over time, this underinflation overdeflects the sidewalls of the tires causing them to fail — needless to say on takeoff or landing. The culprit tires have been identified and procedures changed to reduce the risk of failure.

The brake problems appear to be the result of old style brake assemblies that have been identified as being deficient and are being swapped out for a new style — hopefully, on a faster-than-attrition basis.

The Number 2 emergency escape hatch is still leaving us at the most undesirable times — on climbout. New procedures have been established for the rigging of this hatch that should keep it in place.

Engine problems were highlighted by the engine failure on the Class A mishap. All 2,500 TF33 engines on such aircraft as the B-52H, AWACS, KC-135, and our C-141 aircraft are being inspected to ensure their engines are in good shape. The other engine problems included a failed compressor, an engine starter that failed causing a fire, and a thrust reverser that stuck open because one of its components failed.

continued

C-141 continued

In the miscellaneous category, we had:

- A windshield shattered.
- Thrust reversers were misrigged.
- Nose wheel steering failed.
- Brakes were inoperative on taxi out.
- Dual CADC failure due to water in the lines that froze.
- AHRS and INS failed in-flight.
- Four generators dropped off the line simultaneously.
- A hydraulic "T" fitting failed in the cargo compartment.
- Flight control cables were tight due to being bound with a plastic tie.
- A mechanical pencil was found in the throttle quadrant.
- Apparently an engine cowling that may not have been secured properly.
- There were three other miscellaneous minor mishaps.

Operations-Related Mishaps

Operations/crew mishaps took the middle ground in 1984 dropping slightly from 1983. While the 1984 Class A mishap started with a logistics problem, an engine failure, certain aspects of the mishap had bearing on the operations side of the house. A similar mishap in 1977 did not result in a crash. It behooves all crews to be current and familiar with their procedures and emergency equipment, should they be faced with another mishap like this one.

Taxi, aerial refueling, and tail scrape mishaps all decreased in 1984. Unfortunately, all the other crewmembers besides the pilots still can cause problems.

- Twice, jet blasts from the back of the Starlifter caused damage.
- Twice, conveyer rollers dropped out the back of the aircraft during airdrop.
- Loading struts liked to stay at the last departure station.
- Three crewmembers hurt themselves during low level/fly-by maneuvers (need to be secured better?).
- Aircraft hit a kite during an airshow.
- A nose landing gear scissors pin was not installed correctly.
- An aileron scrapped on landing.
- A leading edge buckled during violent maneuvers while flying low level.
- Runaway pitch trim occurred on takeoff.
- Thrust reverse circuit breakers that were left popped despite a checklist item.

These are indicative of the problems the crews experienced this year due in part to their own help.

Operations-related mishaps are the most difficult for us crewmembers to accept because we know we are better than that. We challenge you in 1985 to show a further decrease in operations caused mishaps. With the professionalism and dedication of proud C-141 aircrews, you can do it.

Other Mishaps

This category is filled with those mishaps usually outside the purview of operations and maintenance. Cargo spills decreased due to altered reporting procedures, birdstrikes decreased, and *fodded* engines still caused eight replaced engines — thus delaying mission ready aircraft. Physiological mishaps increased due to a crewmember with the bends, crewmembers smoking despite a cabin pressurization problem, a pilot eating a bad dinner, and two cases of hypoxia. This is an area needing the attention of everyone, all the time.

Lastly are the miscellaneous mishaps in this category. These include nine lightning strikes (usually resulting in replaced radomes), airdrop malfunctions, and aircraft that taxi over old blast fence spikes.

C-141 Safety Record

We have seen that the C-141 safety record, while continually improving, still has a way to go. The outstanding record of mission accomplishment is due to you, the crewmembers and the maintainers.

Despite marginal weather, long hours, and an aircraft that is getting older, the C-141 is still one of the safest aircraft in the Air Force due to your efforts. Your challenge remains to keep it that way. ■

E-3

MAJOR RAY GORDON
Directorate of Aerospace Safety

■ At the end of 1984, the TAC E-3 fleet had flown a total of 143,322 hours since it became operational in 1977. Last year, the fleet flew 30,089 hours. There have been no Class A mishaps in the aircraft's history.

Although there were also no Class B mishaps in 1984, repercussions from the 1983 midair collision with a KC-135A were a main topic of discussion in command channels.

A comparative look at 1983/1984 Class C flight mishaps shows improvement in most areas.

	1983	1984
Physiological	5	1
Birdstrike	2	1
Air Refueling	2	2
Engines	2	1
Crew Error	1	0
FOD	0	2
Lightning	0	1
Fuel System	0	1
	12	9

The improvement in the physiological area has broken a 2-year trend of crew illness and sinus-block problems. Continue to emphasize flight physiological factors to keep mishaps in this area in check. Remember, see the flight surgeon if in doubt.

Of the two air refueling mishaps in 1984, both involved crew actions. The first was a boom operator striking an air refueling door, and the second was a sudden deviation from the air refueling envelope while in contact.

Training is the key element in air refueling mishap prevention. (For more information on air refueling mishaps, see the article on page 25 of this issue.)

Another high accident potential (HAP) occurred when a controlled fuel dump progressed into an uncontrolled fuel dump. A corroded electrical connector was found to be the root of the problem.

In 1985, the Air Force forecasts 40 operations and 20 logistics Class A flight mishaps. With the forecast 2-to-1 ops/log ratio, we see that our emphasis must be in the operations area to prevent the next Class A mishap. With the AWACS mission, one threat predominates as a potential contributing factor — fatigue.

Some causes of fatigue are built-in to the mission — irregular and long working hours, upset circadian rhythm from multiple time zone changes, and psychological stress, i.e., preparing to go TDY and/or flying a demanding mission. Other causes of fatigue are self-inflicted — inadequate rest, improper diet, lack of exercise, physical stress, and mild hypoxia. Fatigue is insidious — it produces carelessness, sloppiness, irritability, and slowed or inappropriate reactions. It also erodes judgment, causes distractions, channelizes attention, and produces a subtle erosion of performance along with the inability to recognize it.

What can be done to minimize the risks of fatigue effects in the AWACS mission?

First, recognize the problem. Face the fact that a problem exists which can adversely affect your performance.

Second, have a plan. Like hypoxia, we all have symptoms for fatigue — learn to recognize these indications and know what to do to overcome their effects. Prior to every mission, each crewmember should include fatigue when assessing his own personal capability of performing that mission. Countermeasures to avoid the effects of fatigue include proper diet, adequate rest, physical conditioning, hydration, and the common sense to terminate a mission until your alertness and energy are restored.

Lastly, supervisors need to be actively involved by watching for fatigue in their crews and intervening when necessary.

The AWACS mission has some unique elements which pose specific operational safety problems. Operating from forward operating locations stretches the reins of command. With less than normal supervisory situations, crew integrity and self-discipline must be exercised to assure complete mission success.

Overall, the E-3 community has produced an excellent safety record while operating under sometimes austere conditions. The challenge of keeping that record intact is up to each and every one of you. ■

C-12F

■ The C-12F is one of two aircraft types procured to replace the T-39 fleet, the other being the C-21A. The first C-12F arrived at Scott AFB on 11 May 1984 to commence training and operations.

The C-12F is a Beech Super King-air B200C with some modifications. The more significant modifications are a four-blade propeller and a unique combination of avionics. The C-12F is constructed and certified according to the requirements of Federal Aviation Regulation (FAR) Part 23. The C-21A Learjet, by comparison, complies with FAR Part 25. In effect, the C-12F is an off-the-shelf aircraft, but uniquely configured for the Air Force.

Forty C-12F aircraft have been leased from the Beech Aircraft Corporation for a period of five years with an option to extend the lease by three years. The contract also has an option to lease a further five aircraft. At the expiration of the lease, the Air Force has an option to buy these aircraft, which will be wholly maintained by Beech for the duration of the lease. Full contractor logistic support (CLS) will be provided, including en route maintenance by Beech Aerospace Services Inc. (BASI), a wholly-owned subsidiary of Beech Aircraft Corporation.

The C-12F is a T-Tail, pressurized, twin engined, turboprop, passenger/cargo aircraft. It is equipped for IFR/IMC flight operations, day or night, in high density air traffic control zones and into known icing conditions. The C-12F can operate normally from runways less than 5,000 feet in length and can cruise at up to 292 knots TAS and altitudes up to 34,000 feet. With 8 passengers plus baggage, the C-12F has a range of about 1,000 nm; with 6 passengers plus baggage, the range is about 1,200 nm. Maximum cargo capacity is 2,483 pounds.

Beech 200 series aircraft, including the C-12F, consist of more than 1,100 aircraft with 13 different models. There have been 18 Class A destroyed mishaps involving fatalities worldwide, 6 of these in the CONUS. All had operator error involvement. The Air Force has 29 C-12As throughout the world which are Air Force owned with CLS provided by BASI. The C-12A has experienced 2 Class As since entering Air Force service in 1974, both operations related, for a Class A mishap rate of approximately 4.7 per 100,000 flying hours. There have also been 3 Class B mishaps and 2 Class C mishaps with a dollar cost of more than $99,000 each.

The role of the C-12F is VIP transport on the shorter routes; the C-21A taking the longer routes. The proven reliability of the C12A augurs well for the future of the C-12F in this role. ■

C-20A

■ On 1 September 1983, the first C-20A aircraft became operational at Andrews AFB with the 89th Military Airlift Wing. By mid-November 1983, three aircraft were operational. These aircraft, military versions of the Gulfstream III, were leased to replace aging C-140Bs. They will provide airlift support to the President, Vice-President, Cabinet members, and other high-ranking dignitaries of the United States and foreign governments.

In 1983, USAF directed procurement of an "existing off-the-shelf

FAA certified business jet-type production aircraft in an executive configuration" to replace the C-140B in the Special Airlift Mission (SAM) role. On 6 June 1983, the selection of the Gulfstream III was announced.

The Gulfstream III is basically a derivative of the earlier Gulfstream II, and, in fact, is 75-percent common. Several changes were made to provide an aircraft that better met the needs of the 1980s.

The Gulfstream III was certified in 1980. There are approximately 130 in service, and they have amassed a total of over 76,000 flight hours.

From the 40-percent chord forward, the wing incorporates a new technology airfoil. The leading edge extension also incorporates a new front beam, resulting in an integral fuel tank. In addition, the wings were extended three feet at each wing tip, with NASA winglets fitted thereto.

The fuselage arrangement for the Gulfstream III was also changed slightly. A longer radome was added. The cockpit was reconfigured, and wraparound windshields were added to improve the cockpit noise environment for the crew. Passenger cabin volume was increased by adding a two-foot extension directly aft of the main entrance.

The aircraft has a maximum takeoff weight of 69,700 pounds, a maximum cruise speed of .85 Mach, and can operate to 45,000 feet.

The three C-20As now in service are approximately 98-percent common with the commercial Gulfstream III. Only six minor differences in avionics, such as a Mode IV transponder and HF radio, differentiate the two. The C-20A aircraft have a crash data recorder, a crash position indicator, cockpit voice recorder, and a ground proximity warning device.

The C-20A is outfitted to carry 14 passengers and a crew of 5. The cabin has a communications compartment forward, and there are two compartments for passengers. The center executive compartment features a five-place conference arrangement, while the aft staff compartment provides work space with a conference seating arrangement for nine persons. A full-service galley and a lavatory/dressing room are located in the rear of the cabin. In addition, there is a fully pressurized walk-in baggage compartment.

The Rolls-Royce Spey MK511-8 turbofan engines (each develop 11,400 pounds of thrust) have proven to be highly reliable in Gulfstream and other civil and military aircraft around the world. According to Gulfstream records, engine removals for maintenance on 325 aircraft averaged only one per 11,400 engine hours. Engine shutdowns in flight averaged one per 100,000 engine hours.

The MAC beddown plan calls for eventually having eight C-20As at Andrews AFB and three at Ramstein AB.

C-21A

■ In 1984, one of the new operational support aircraft, the C-21A, began operations at Scott AFB.

The C-21A is a Learjet Model 35A specially outfitted for Air Force operations. The aircraft is constructed and certified to the requirements of Part 25 of US Federal Aviation Regulations. It is powered by two thrust-reverser equipped Garrett TFE731 engines, each developing 3,500 pounds of thrust. At maximum takeoff gross weight, the C-21A can operate from runways less than 5,000 feet in length and can cruise at speeds up to .81 mach at altitudes up to 45,000 feet. With 6 passengers and baggage, the C-21A has a range of over 2,100 nm with a 45-minute fuel reserve.

Eighty C-21s will be leased from Gates-Learjet Corporation (GLC) for a period of five years with an option to buy. The aircraft will be totally maintained by GLC contractor logistic support, including en route maintenance. Routine servicing at en route stops will be provided by Air Force Transient Alert.

The Learjet Model 35 was leased as an off-the-shelf business jet. The avionics package supplied in the C-21A consists of some standard instrumentation supplied to all Gates Learjet aircraft and some off-the-shelf options.

The Air Force uses the C-21A for VIP transport, the traditional role of the T-39. By 1986, the T-39 aircraft will have been retired after 25 years of loyal service. The already proven capabilities of the C-21A show it to be a worthy successor to the T-39. ■

C-23A

■ The Short Brother's C-23A is being acquired by the Air Force as the aircraft element of the European Distribution System (EDS).

The EDS is a logistics system to provide United States Air Forces in Europe (USAFE) the assured distribution of critical assets to support war and peacetime tactical air and other critical USAF operations in the European theater. The system consists of three elements.

The first of these is the communications and data processing system to source and direct the distribution of critical spares. The second is the forward stockage of spares deployed in Europe to offset expected wartime damage to retail spares. The third element consists of 18 cargo-type aircraft for the assured movement of critical spares, including fighter aircraft engines. All three elements were to be off-the-shelf with modifications to be made only when absolutely necessary.

In March 1984, Short Brothers Limited of Belfast, Northern Ireland, was awarded a contract to provide a modified version of their SD 330 Sherpa aircraft to meet the EDS requirement. It is an unpressurized, twin-engined, turboprop aircraft having a strut braced, cantilevered high wing and a full width rear loading ramp type door.

The C-23A basic crew will be two pilots and a flight mechanic (AFSC A431XX) who will perform both flight mechanic and loadmaster duties.

The C-23A has provisions for the installation of folding passenger seats to enable the aircraft to be operated in passenger or mixed cargo/passenger transport roles. Up to 18 passengers can be carried. Seating for six passengers is normal.

Although the C-23A was to be an off-the-shelf procurement, 60 modifications were made that make it unique to the USAF. Major modifications include:

- Air Force-unique avionics package, completely different from the commercial 330.

- Increased capacity fuel system. All fuel is carried in two separate fuel tanks mounted on top of the fuselage over the cabin area. One tank is located forward of the wing, and the second tank is located aft. A crossfeed system allows fuel from either tank to feed either/both engines.

- A crew oxygen system has been added to the C-23A. This system features four individual oxygen diluter demand/100-percent regulators for the pilots, flight mechanic, and flight observer. This oxygen is not intended for routine, continuous use, but it can provide the 4 crewmembers with 100-percent oxygen for 30 minutes.

- A major difference between the civil 330 and the C-23A is the addition of the flight mechanics station. Civil operators do not fly with flight mechanics. There is also a flight observer's seat located in the cockpit behind and to the left of the pilot, which can be stowed when not in use.

- Cargo roller conveyors. The civil 330 has a flat floor. To make cargo handling easier and more rapid, the C-23A's floor is roller-equipped.

The aircraft is powered by two Pratt and Whitney PT6A-45R engines and has a max gross weight of 22,900 pounds. With a crew of 3, it has a max payload of 4,200 pounds with a range of approximately 400 nm. It has a max range of 789 nm with a 2,800 pound payload and cruises at or below 10,000 feet at an airspeed of 157 KTAS.

To manage and operate the C-23A, a new squadron, the 10th Military Airlift Squadron, has been established at Zweibrucken Air Base, Germany. The aircraft and aircrews will be assigned to this MAC squadron, but USAFE will have priority on their use.

The Short Brothers SD330 was first certified in 1976, and the 93 aircraft currently in service have flown a total of 577,000 hours. During this period, there have been no catastrophic failures, major mishaps, or injuries.

This enviable record indicates that the C-23A, properly operated and maintained, will be a safe, valuable addition to our airlift fleet. ■

The Air Refueling Scene

MAJOR RAY GORDON
Directorate of Aerospace Safety

■ Although this issue of *Flying Safety* concentrates on "the heavies," this article is important to anyone who has ever heard "breakaway, breakaway, breakaway" ringing through their headset. We will focus attention on recent air refueling (A/R) mishap history and efforts to improve/standardize air systems.

Aerial refueling has come a long way since Maj Spaatz' and Capt Eaker's 1929 flight of the "Question Mark." Since that time, A/R has played a major role in deploying and employing tactical and strategic air forces into crisis areas around the globe. Two examples of when A/R became critical was during the Arab-Israeli war of 1973 and the recent Falklands conflict of 1982. Since those two conflicts, the US and the United Kingdom (UK) have reassessed their A/R capabilities and procured needed new tanker weapon systems — the KC-10 in the US and the VC-10 in the UK. In the US, there still will be a tanker shortfall because of growing worldwide A/R commitments, in spite of ongoing production of KC-10 aircraft, the KC-135 reengining programs, and technological improvements to A/R systems.

The 1990 US/NATO/Allied force projections indicate almost a 15-to-1 receiver-to-tanker ratio. Additionally, the projected receptacle-to-boom ratio is over 9-to-1, while the probe-to-drogue ratio is projected to be almost 26-to-1.

Because of the critical nature of A/R capabilities to the defense of our nation and our allies, and the increasing costs of repairing A/R systems due to mishaps, it is mandatory that we thoroughly investigate, analyze, and report the cause of mishaps. Mishap reports are used to prevent future mishaps by recommending improved/standardized equipment or procedures. However, only those mishaps which are "reported" can be used in this analysis. We know that there are a sizable number of potentially hazardous situations not reported because of the $1,000 damage threshold necessary for a Class C mishap. Remember, you should report any hazardous situation as a high accident potential (HAP) mishap.

Air refueling mishaps have traditionally been the leading cause of most mishaps in Air Force KC-135 and KC-10 tankers (even ahead of damaging bird strikes). Here are KC-135 and KC-10 A/R mishap statistics from recent years.

Figure 1
Air Refueling Mishaps

Year	Mishaps	Rate/ 10,000 Hrs
1980	32	1.27
1981	30	1.15
1982	35	1.32
1983	44	1.62
1984	36	1.28

These mishaps can be further broken down into two categories: Mishaps caused by boomer/receiver operational errors and mishaps caused by A/R systems malfunctions. Of the 36 mishaps in 1984, 23 were caused by boomer/receiver error. Of the 13 A/R "systems" mishaps, the KC-135 experienced 9, with 2 involving probe and drogue refueling systems. Of the 4 experi-

continued

The Air Refueling Scene continued

enced by the KC-10, 3 involved probe and drogue systems. Here is a comparison of mishap totals over the last two years by aircraft type and mishap category.

Figure 2
Air Refueling Mishaps By Type Aircraft

Type Aircraft	Ops Errors (83/84)	Systems Malf (83/84)
Receptacle-Equipped Aircraft		
F-4	5/4	0/1
F/FB-111	5/0	0/0
F-106	4/2	0/0
A-10	1/1	0/2
A-7	1/0	0/0
F-16	0/1	0/0
C-141	4/3	0/0
B-52	3/1	0/0
E-3	2/2	0/0
C/KC-135	2/1	0/0
KC-10	0/1	0/1
C-130	1/1	0/0
Drogue-Equipped Aircraft		
OA-37	0/1	4/1
F-4	1/2	1/1
A-4	0/0	1/2
A-6	0/2	0/0
F-18	0/1	0/0
AV-8	0/0	0/1
Other Tanker Refueling Systems Malfunctions		
KC-135	N/A	9/3
KC-10	N/A	0/1
Totals	29/23	15/13

From the above data, it is evident that these mishap totals, although improved from the previous year, can still go lower. Training has been the key element in solving the operations-related A/R mishap. In fact, most recommendations from these mishaps relate to training improvements. The challenge is to identify training deficiencies *before* the mishap occurs. The good training program should ensure adequate supervision, thorough procedural and systems knowledge, and a common sense approach of knowing when to terminate refueling.

An example of training deficiencies was shown by a 1983 Navy A-4/KC-135 Class A mishap. The normal closure speed required for contact for the Navy/Marine hose reel system is much higher than for the KC-135 boom drogue adapter (BDA). The Navy pilot was not fully aware of this difference. His technique caused hose separation and fuel ingestion, resulting in engine fire and explosions. As a result, the Navy has established procedures for certifying their pilots for refueling with Air Force tankers — a viable recommendation.

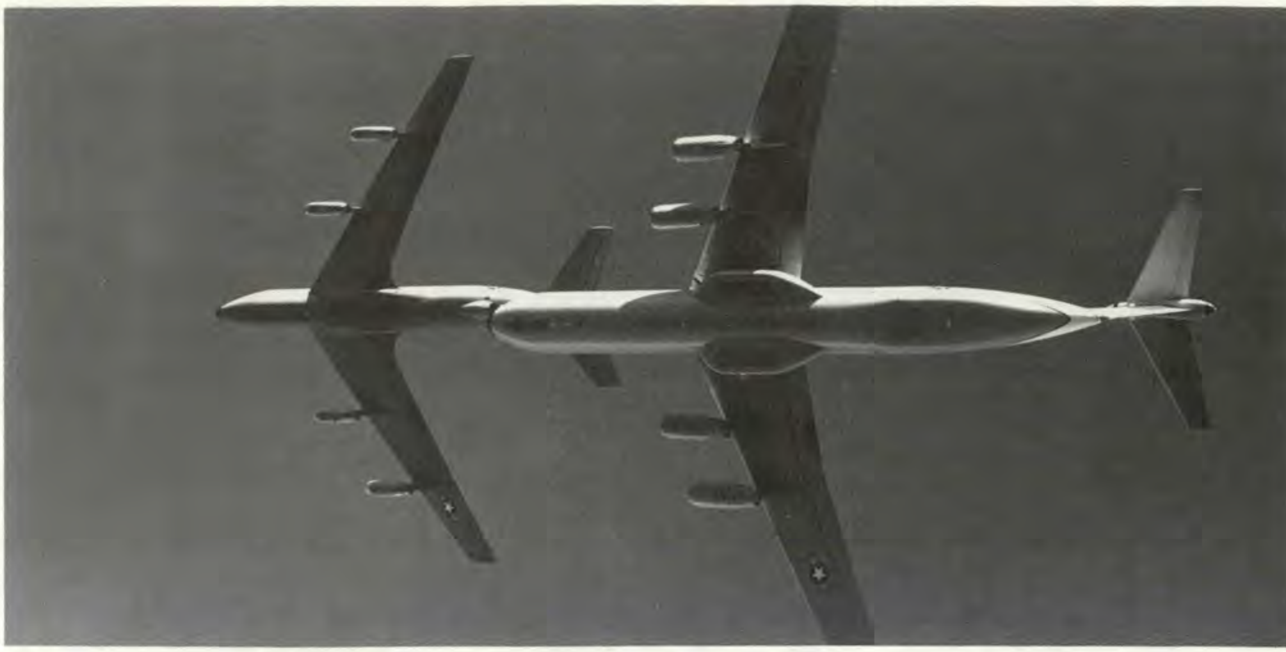
There are many other factors which may cause mishaps — aerodynamic effects, visual illusions, spatial disorientation, system incompatibility, and system malfunctions.

Aerodynamic effects, to anyone who has refueled, are well known. Complex aerodynamic forces must be anticipated whenever the receiver aircraft moves into or out of refueling position. This is especially true for large aircraft. The approach speed and angle affects the magnitude of trim changes required by both aircraft. The slower the closure speed and the flatter the approach angle, the more manageable the pitch trim changes will be for both aircraft.

Visual illusions and spatial disorientation can be a problem for receiver pilots and the boom operator. Contradictory sensory inputs commonly result in the "leans" — the illusion of turning. At night, problems can be compounded due to the lack of visual cues. Pilots must slowly scan the entire tanker to maintain good positional awareness. With the advent of European camouflage paint schemes, the boom operator has a greater challenge. Even with the fin tip mounted flood light, the receiver's top surface will visually appear flat. Aeronautical Systems Division (ASD) is working on "lead-in lighting" to solve some of these problems.

Mishap investigators should be especially aware of human factors aspects of A/R mishaps. Fatigue, and its many resulting effects, may play a bigger part than at first glance. Mishap recommendations are based on causal factors; this is why it is so critical that all causes are determined, not just proximate causes.

System incompatibility problems are primarily associated with refueling non-Air Force receivers. Often, refueling systems were not developed through joint ventures between the manufacturers. One example of this exists with the MA-3 coupling in the KC-10 and the probe nozzle on the Marine AV-8 Harrier. Investigation revealed mating hardware dimensionally incompatible. While development of A/R systems has concentrated on boom/receptacle and probe/drogue modes of refueling, many hardware varia-



tions have complicated the compatibility and interoperability objective of US/NATO/Allied tanker/receiver fleets.

These are concerns of the Air Refueling Systems Advisory Group (ARSAG), a single interservice agency within DOD which meets semiannually to advise on aerial refueling systems matters. It also serves as an advisory body for the resolution of existing deficiencies in tanker and receiver A/R systems and for the development and implementation of improvements to these systems. Other areas of system incompatibility the ARSAG is interested in are A/R standard terminology, standard lighting schemes, and standard boom/hose markings, to name a few.

Air refueling system malfunctions are another major area of concern. Sometimes, what is first perceived to be a system malfunction is actually a design deficiency, a system incompatibility, or a lack of adequate technical data. One example of this is the series of OA37 engine flameouts due to fuel ingestion. At first, it was determined that the inspection requirements on the drogue couplers were inadequate. Then it was discovered that poor receiver probe positioning during contact affected connection integrity, resulting in a recommendation to upgrade the probe nozzle with a more "flexible" nozzle. It is of critical importance to use the Materiel Deficiency Reporting (MDR) System to identify maintenance and materiel cause factors.

In another 1984 example of a system malfunction, an A-4 was lost while refueling from a KC-10. For an unknown reason, the hose reel system failed to take up slack, resulting in hose oscillations and hose rupture at the drogue. Again, fuel was ingested by the A-4, and fire and explosions dictated an ejection by the pilot. ASD and the contractor are just completing a comprehensive study of the KC-10 hose reel system to determine near- and long-term improvements to preclude similar mishaps.

Probe and drogue-dedicated refueling in 1984 accounted for 6 percent of the KC-10's flying time and only 1 percent of the KC-135's flying time. Based on the number of probe and drogue mishaps and the flying time logged specifically for probe and drogue refueling, the chances of having a mishap with either drogue system are over 25 times greater than with boom systems. The KC-135 BDA was originally designed as an interim system that has never been replaced with a permanent system. ASD is currently testing a hose reel replacement for the BDA, but until it is replaced, pay close attention to this system. Meanwhile, you can expect the Strategic Air Command to be tasked with increasing A/R commitments with non-Air Force receivers having probe systems.

In order to identify trends so that future mishaps can be prevented, a recent change to AFR 127-4, Investigating and Reporting US Air Force Mishaps, requests additional information about A/R mishaps. As crewmembers, what you can recall of the following factors may play an important role in helping investigators find out what caused the mishap: A/R boom position during the mishap, an estimate of boom forces present during disconnect, whether excessive fuel spray/leakage was present, effect of the new camouflage paint schemes on depth perception, signal amplifier status, and the type and effect of aircraft lighting. Please make a note of this information, as investigators will require it for the mishap report.

Many A/R mishaps can be prevented. Repeat causes are very obvious. Thus, it is imperative that we do our utmost to prevent A/R mishaps to save aircraft resources and sometimes lives. Reporting mishaps, potential mishaps, and materiel failures are tools that should be used in a good mishap prevention program. Most importantly, be alert and fly a stable platform. ■

1984 USAF Ejection Summary

RUDOLPH C. DELGADO
Directorate of Aerospace Safety

■ In 1984, aircrews flying in ejection-seat equipped aircraft had 61 ejections. Fifty-two of these survived, for a reasonably good 85-percent ejection survival rate. Thus, the good trend which started in 1982 with 89 percent and 1983 with 84 percent, continues. The previous 6 years we averaged 75 percent.

The 11-percentage point improvement of the ejection survival rate in the past 3 years over the previous 6 probably cannot be attributed to any one thing we are doing differently. It is, most likely, a combination of several factors such as improved aircrew situation awareness, better training retention, improved motivation and preparation for the timely escape decision, the influence of the ACES II seat, and some luck.

Figure 1
1984 Ejection Results By Aircraft

	Injury Classification					
Aircraft	Fatal	Major	Minor	Minimal	None	Total
A-7	2		1	2		5
A-10	1			1	1	3
B-1	1	2				3
B-52	1	4	1			6
F-4	1	3	4	11	4	23
F-5			1		1	2
F-15		1	1		1	3
F-16	1		1	1	1	4
F-106			1			1
F-111	2	1			1	4
T-37			2			2
T-38		2		1		3
TR-1		1				1
U-2				1		1
Totals	9	14	12	17	9	61

The total 1984 USAF ejection experience is shown in Figure 1. It shows that of the 52 survivors, 14 sustained major injuries, 12 had minor injuries, 17 had minimal injuries, and 9 were not injured. It also shows some ejection experience for some aircraft which heretofore had not had any.

We lost the first B-1 in history and also the first TR-1. This B-1 was one of the first three built equipped with a crew escape module (CEM). The aircraft was on a low level mission when it went out of control, and the crew ejected. Because of a problem in the recovery parachute repositioning system, the CEM landed on its nose. Although the ejection was not 100-percent successful (fatal injuries to the copilot and major injuries to the pilot and the flight engineer), it could have been much worse. The crew made a very timely ejection decision considering the fact they were flying at low altitude, out-of-control, and that the CEM needs about 11 seconds to operate.

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A crew such as this one, flying a $325 million, almost a one-of-a-kind aircraft (at the time), would be expected to be highly motivated to "attempt to overcome the problem" and all could easily have been killed in the process. Instead, they did attempt to overcome the problem but recognized when it was time to eject and did so. They had about 2 seconds left in the envelope. Ejection parameters were 1,515 feet above the ground, 118 knots, 22-degree dive, and 28-degree right roll.

The TR-1 has a Lockheed R-2201 ejection seat. The aircraft had an engine fire, and the pilot ejected at 450 feet, 60 knots, 40-degree dive, and 10-degree left bank. The canopy did not jettison, and the seat went through it. The pilot sustained a T-5 compression fracture and a fractured molar.

Besides the B-1 aircraft ejection fatality, there were five out-of-envelope; one due to maintenance malpractice, one due to escape system damage, and one crewman that was struck by a piece of aircraft after ejection.

Of the 14 aircrews that had major injuries, 6 were due to parachute landing, 4 more were caused by ejection acceleration, 2 were due to system malfunction, and 1 each were due to procedural error and striking the cockpit rail on the way out.

In 1984, we also had a B-52G aircraft mishap where all 6 crewmen occupying ejection seats ejected after the aircraft had struck the ground. The aircraft was descending to start a terrain avoidance training mission when it struck a 1,165 foot mesa, 235 feet from the top, with its right wing. It rolled right and started to break up, but the 6 ejection seat-equipped crewmembers were able to eject. They all cleared the aircraft, but a piece of aircraft debris struck one of them causing his ejection to be unsuccessful. The other 5 crewmembers, although injured, survived.

This one mishap probably involved all but one of the factors mentioned in the second paragraph of this article concerning reasons for the improved ejection survival rate. The circumstances could not have been much worse. It was at night, low level, cold, snowing, and raining. The terrain was extremly unhospitable. It was mountainous and rocky with steep slopes covered with huge boulders on which a couple of the crewmembers landed.

After striking the mesa, the aircraft flew no higher than about 150 feet. (The downward seats need a minimum of 250 feet altitude to operate.) The fact that the aircraft rolled probably gave the two downward ejectees the trajectory they needed. Both survived. This crew also made a very timely ejection decision.

Figure 2
Escape System-Equipped Aircraft Mishap Results

	Crewmen Number	Crewmen Percent
Ejected/Survived	52	58
Ejected/Fatal	9	10
Not Ejected/Survived	7	8
Not Ejected/Fatal	21	24
Totals	89	100

Figure 2 shows that 89 crewmembers flying in escape system-equipped aircraft were involved in mishaps. Fifty-two of these ejected and survived while 9 were ejection fatalities. Twenty-one of the 28 that did not eject resulted in fatalities. The 7 that survived involved runway mishaps where the crew (6 in a B-52 and 1 in an F-4) either had time for emergency ground egress or were rescued in time.

If we consider the 5 out-of-envelope ejection fatalities and the 21 nonejection fatalities, we can see that a timely escape decision might have saved even more aircrews. We know not all of these had the opportunity, but we think some of them did.

In summary, while improved situation awareness helped save some lives in 1984, there is still room for considerable improvement. ■

SAFETY AWARDS

THE SICOFAA
FLIGHT SAFETY AWARD FOR 1984

At the Conference of the Chiefs of the American Air Forces (CONJEFAMER) in May 1976, the Chiefs approved establishing the System of Cooperation Among the American Air Forces (SICOFAA) Flight Safety Award to recognize aircraft accident prevention achievements. Each Air Force determines its own criteria and annually grants this award to one of its units.

314 TACTICAL AIRLIFT WING

■ The 314 TAW, the largest tactical airlift wing in the world, flew over 50,000 hours in 1984 without a Class A or B mishap. This caps more than 3 years and over 140,000 flying hours without a Class A or B mishap. The Wing aircrews operated aircraft worldwide in all types of weather, fulfilling mission requirements from multiship formations in marginal weather to night, heavyweight assault landings on small unimproved dirt landing zones.

In addition to the worldwide tactical airlift mission, the Wing has also provided initial qualification, upgrade, or requalification training for over 2,700 crewmembers. Graduates include pilots, navigators, flight engineers, and loadmasters from all Department of Defense agencies and several allied countries. The squadron which is responsible for this training has flown for 12 years and over 210,000 hours without a Class A or B mishap.

The maintenance effort of the 314 TAW was equally important to the Wing's outstanding record. When faced with a series of special inspections which expanded workloads for maintenance and increased downtime for the airframes, the fine efforts of the maintenance organization resulted in continuation of the important aircrew training mission while maintaining two operationally ready airlift squadrons.

The exceptional mishap prevention program efforts of the Wing have been recognized through awards and commendations by Air Force and civilian agencies, typified by an award from the Aviation Safety Institute.

The air discipline and professionalism of the aircrews, the excellence of aircraft maintenance, successful operations in the realistic tactical airlift training environment, the effective safety program management, and the outstanding accident prevention accomplishments of the 314 TAW are most deserving of recognition accorded by the SICOFAA Flight Safety Award for 1984. ■