AEROSPACE

SAFETY • MAGAZINE FOR AIRCREWS APRIL 1980

Another Case Of F.O.D.

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■ Just about everyone has heard stories about "Big Ugly" that left you scratching your head and muttering "how did that happen" but here is one that really occurred and falls in the category of amazing.

Seems that one of the F-4s stationed at this base kept coming home with fuel feeding anomalies that were just a little bit on the weird and unusual side of the dash one limits. So, maintenance, after having exhausted most of their troubleshooting procedures, decided to surround the problem by tearing into the fuel system for a somewhat closer look. Now, this turned out to be just what was needed; the culprit and cause of the funny business being a couple of pieces of polished glass that were found in one of the fuel transfer valves. Most surprising of all was the fact that these pieces of glass were of about the same consistency, optical density and color as the glass of a *Coke®* bottle. As a matter of fact, one piece had raised lettering remaining that just about fit the K in *Coke®*, if you had a little imagination.

This was indeed strange! A rather thorough search of applicable pubs could turn up nothing recomending feeding of cola bottles to F-4s as approved procedure. Nor was the direct injection of ground-up glass into the primary fuel tanks considered too good an idea by anyone concerned.

Normally, the story would have ended right there, but in this case there was another twist in the tale. The local Q.C. was run by a crusty lieutenant colonel who had been on station for quite some time and who was also possessed of a rather good memory. He seemed to remember that quite some time ago, he had encountered similar problems with an F-4 while on TDY to one of the more remote duty locations. He quickly checked his old TDY orders and found that yes, indeed, he had flown this same aircraft on a TDY two years ago (truly amazing)!

A call out to this base quickly turned up an old line chief who had been on station there for two plus years. Not only did a records search reveal that the same aircraft had undergone fuel tank maintenance, but the line chief (at that time a crew chief) had been involved. Yes, sir, he remembered what was wrong – had to remove several pieces of a *Coke®* bottle from the primary fuel tank! Did he have any clue as to the origin? No, sir, nothing on record in that area since depot level maintenance and that had been almost a year prior.

So, the mystery remains. No one really knows the origin of those pieces of glass. We do know that they had been in there for quite some time. How the F-4 managed to digest and pass as much of the glass as it did is truly amazing. Why there were never any larger problems than abnormal fuel balances is also interesting. Sometimes luck carries you through. Sometimes truth is stranger than fiction! ■

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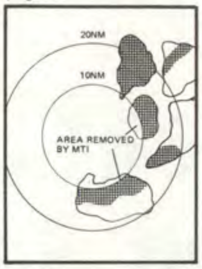

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SPECIAL FEATURES

REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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Inflight Weather Avoidance Service

How can ATC controllers assist aircrews in avoiding thunderstorms? How do they get weather information? What are the limits of their radar? What is the controller's responsibility to aircrews in weather avoidance? These and other questions are answered in this article. Based on a study prepared for a Safety Investigation Board following a fatal aircraft accident caused by a lightning strike, this article should be read by all aircrew personnel.

ATC Radar

■ Radar is a method whereby radio waves are transmitted and are then returned when they have been reflected by an object in the path of the beam. The object could be an aircraft, a ground return, or precipitation.

It is very important for aviators to recognize that there are limitations to radar service and that ATC controllers may not always be able to issue weather information and provide a service. Radio waves are such that they normally travel in a straight line unless they are bent by abnormal atmospheric phenomena such as temperature inversions, reflected by dense objects such as heavy clouds, precipitation, ground obstacles, mountains, etc., or screened by high terrain features. Radar energy that strikes dense objects will be reflected and displayed on the controller's scope. Aircraft (regardless of their altitude) operating at the same range as these dense objects will be blocked out. Aircraft beyond (at a greater range) may also be blocked from the controller's view.

Figure 1 illustrates a radar scope that displays a large dark area of weather returns. The radar return is probably not a thunderstorm but heavy stratus clouds containing precipitation. Obviously, this presentation is unacceptable since aircraft operating on the easterly quadrant of the radar scope could not be seen and are blocked.

Figure 2 illustrates a typical radar scope when thunderstorms are present. The figure has five weather cells that are probably "CB" type. The outline of each cell is the actual dimension of the build-up area. However, only the black areas are displayed on the scope. Aircraft targets that can be seen by the controller are indicated by the numbers 1, 2, and 3. There may be others within 20NM that the controller cannot see which are being blocked by the weather returns. This radar presentation is a raw display – no special features are used to reduce the effects of weather on radar.

There are some important limitations displayed on Figure 2 that should be noted. Weather cell "A"

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Det 2, 67 ARRS

is blocking part of weather cell ''B''. Only the dark area of ''B'' is seen by the controller; however, the outline of the cell indicates its actual size. In other words, existing thunderstorms may not be seen if there are other thunderstorms in front blocking them out. Remember, radar will be reflected from the first dense object. A controller could vector an aircraft through area ''B'', believing it is clear. Area ''C'' is seen on the scope because it is taller than ''A'' and the radar waves go over the top. ''D'' is the front part of a thunderstorm and is displayed; however, area ''E'' is not seen as it is lower and being blocked by ''D''. In summary, controllers do not always see the entire area weather cell or thunderstorm area since radar waves will be returned from the first and highest precipitation area.

Figure 3 is a side or profile view of the area within 30NM of the radar antenna. Only aircraft nr 6 would be displayed on an ATC radar scope. The other aircraft (one through five) would be blocked by weather cells even though some aircraft may be above or below the weather. In this instance a dangerous conflict exists between aircraft nr 6 and nr 3 which are flying directly at each other at the same altitude. Unfortunately, the controller would be unable to separate the two aircraft since nr 3 is not displayed on this scope.

Radar Special Circuits

In order to improve the display of aircraft on the scope, technicians developed certain special circuits to eliminate weather cells.

Fast Time Constant (FTC) can be selected by the controller to change the image on the scope. When this mode is used all of the indicators in the facility are changed since the feature works directly on the single antenna head. Therefore, if there are three scopes in a radar unit, all three will be changed. This is true of all special features. FTC removes most ground and weather returns by eliminating all but the leading edge of the return. FTC does not affect the secondary or transponder return. This special circuit allows the controller to track aircraft targets through moderate to heavy returns (see Figure 4). This was the first feature designed by radar engineers to assist controllers by improving the radar presentations.

Figure 4 indicates the display seen when FTC is selected. As you can see, the ''CB'' return area has been reduced and only the edges closest to the antenna are now portrayed. Number 4 aircraft can now be seen by the controller since the blocked out area has been reduced. An inherent limitation of this feature is that the display of aircraft can easily ''blend in'' with the weather or ground returns. Tracking an aircraft can be difficult.

Figure 5 is a profile or side view that shows how FTC can improve the scope presentation by reducing the area blocked by weather returns. Aircraft 6, 4, and 2 are now displayed and separation can be applied between those aircraft. Only the dark portion of the weather cell will be displayed on the scope.

Circular Polarization (CP) was

FIGURE 1
RAW RADAR
WEATHER
RETURNS
NOT
"CB" TYPE

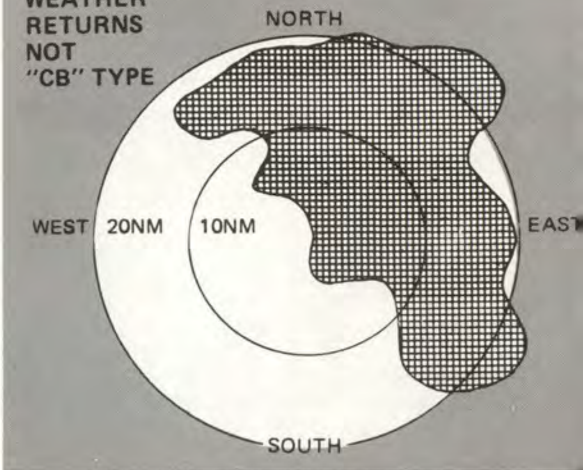


FIGURE 2
RAW RADAR

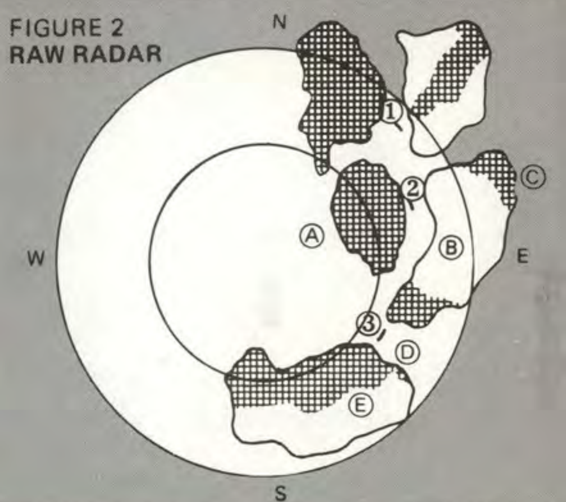


FIGURE 3
RAW RADAR

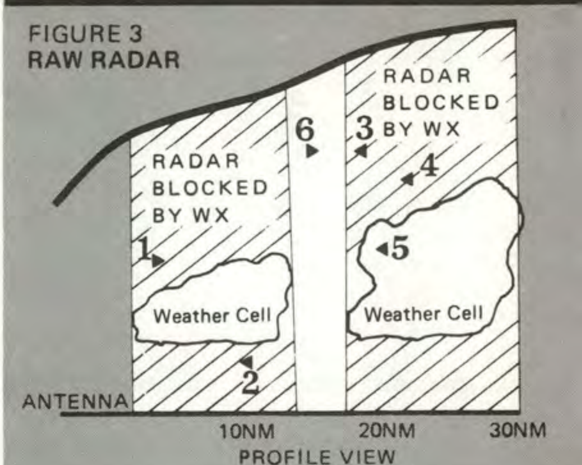


FIGURE 4
RADAR
WITH
FTC

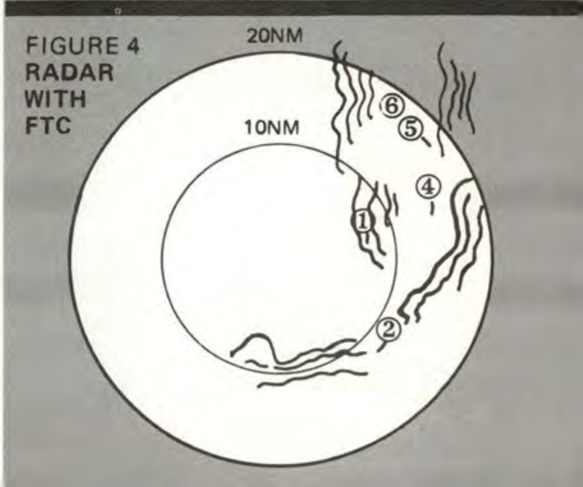


FIGURE 5
FTC

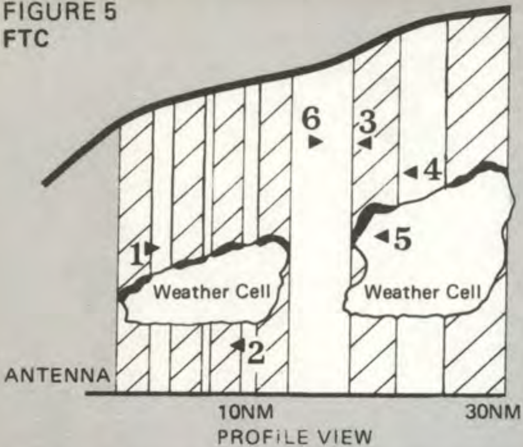


FIGURE 6
RADAR
WITH
CIRCULAR
POLARIZATION

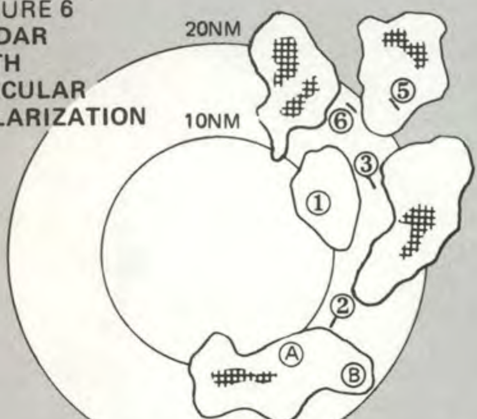


FIGURE 7
CIRCULAR
POLARIZATION

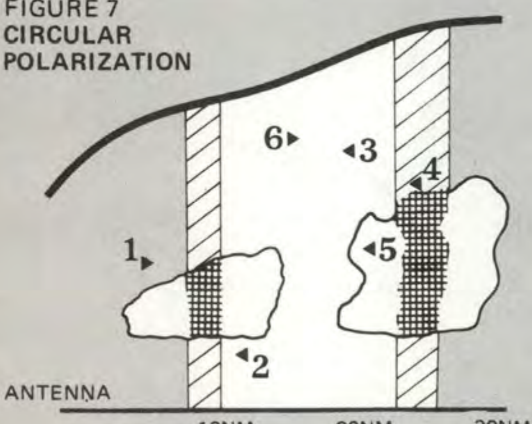
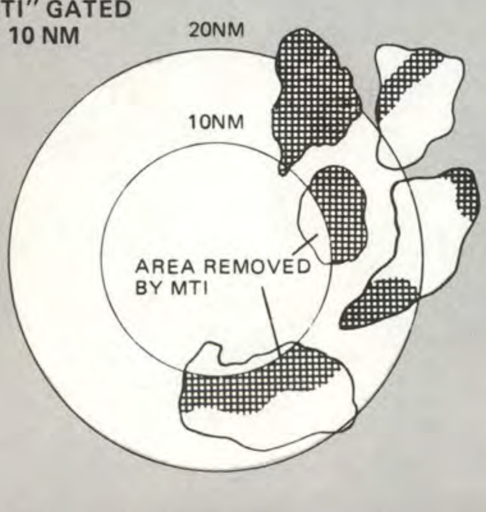


FIGURE 8
"MTI" GATED
AT 10 NM



later installed to offset and compliment FTC (see Figure 6). CP is designed to reduce, as far as possible, precipitation clutter from the radar indicator. However, it does not completely remove intense clutter which is usually associated with thunderstorms. Only the heaviest portions of the weather cells appear on the scope. This is indicated by symbol A, Figure 6.

The outline surrounding the dark cell areas (symbol A) is the actual dimension (symbol B) of the thunderstorm, but is not seen by the controller when using CP. Therefore, an aircraft could be vectored through part of the thunderstorm (area B) unknowingly by the computer.

Figure 7 depicts the profile or side view of how CP works and enables the controller to eliminate weather returns which allows more aircraft to appear on the scope. By using CP, only aircraft nr 4 is blocked by the weather cell. Knowing that CP eliminates almost 70% of weather returns, controllers should use CP only if there is a possibility of losing an aircraft target in the precipitation clutter. CP can be cycled in approximately 7 seconds and supervisors can operate back and forth between raw (linear) and CP to track aircraft through thunderstorms.

Moving Target Indicators (MTI) is a special circuit that is able to distinguish between moving and stationary targets with limited efficiency (see Figure 8). If a target is moving at less than a specified speed, it will be eliminated from the scope. The main purpose of MTI is to eliminate ground returns such as buildings, trees, and other terrain features. It can also eliminate or reduce weather returns. At most terminal ATC facilities the MTI is used to a range of 5 to 10 miles from the airfield to reduce these unwanted returns. This often will eliminate portions of weather cells that could affect landings and takeoffs (symbols A and B).

To summarize:

Radar can detect weather cells. Often it is difficult to determine if the precipitation on the scope is a thunderstorm or stratus clouds.

Only the surface closest to the radar antenna will be displayed and often the ''backside'' of the cell is blocked by its frontal portion.

Since the ATC radar is used to separate aircraft, technicians designed certain special features to eliminate weather in order to display aircraft operating in or near these precipitation areas. Weather cells occasionally prohibit controllers from providing an aircraft radar separation service. Ground returns also can be eliminated by these same special circuits which include FTC, CP, and MTI. Each circuit can be used independently or in conjunction with another.

There are no established procedures for use of these special circuits. Each controller (assisted by the supervisor) should determine which circuit(s) are required for the best presentation. Atmospheric conditions and workload are considerations for this selection. Ideally, a controller should attempt to eliminate only the weather required to prevent losing aircraft being controlled. He should try to display as much weather

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WHIFFERDILLS DIVERGENCES AND OTHER ROLL COUPLING PHENOMENON

BY LARRY WALKER
Experimental Test Pilot

■ Nearly every fighter pilot has, at one time or another, done consecutive aileron rolls out of the sheer exuberance of flying, yet suffered no severe consequences. And don't flight demonstration teams regularly do multiple aileron rolls? So, you ask, why are full deflection rolls beyond 360 degrees normally prohibited? Or often, full deflection rolls normally restricted at less than + 1.0g? Let's take a look at some roll-coupling problems which make these restrictions necessary and some of the underlying principles which cause them.

The origins of roll coupling always seemed mysterious to me – after all, aren't bullets spin stabilized? If so, then why can't an airplane roll safely at maximum rate for as long as the pilot may desire? The answer is that it is possible, theoretically, but only if the roll rate exceeds a certain minimum value. But, unfortunately, just below this minimum value exists a critical roll rate which reinforces the airplane aerodynamic modes of motion and can cause divergence and possible structural disintegration. Therefore, even if we could roll faster than this minimum value, we would first have to accelerate through the critical rate, making the maneuver extremely hazardous. Fortunately, in most cases and flight conditions, the maximum attainable roll rates are less than critical.

The Coupling Phenomenon

Coupling, by definition, occurs when a disturbance in one axis causes a disturbance in another axis. To illustrate, a longitudinal stick input excites only the pitch axis, producing a single-axis, non-coupled response. A rudder input, on the other hand, excites both the yaw and roll axes, producing a two-axis, coupled response. In this case, the coupling mechanism is aerodynamic – rudder yaws the airplane and dihedral effect rolls it. However, the coupling mechanism can also be due to inertia. For example, inertial forces at high roll rates acting on the airplane can disturb its aerodynamic balance, and in extreme cases, completely overpower its natural stability, sometimes with catastrophic results. However, it is an oversimplification to blame inertial coupling only for roll-coupling problems because in reality roll coupling is composed of three inter-related (and inseparable) coupling mechanisms – kinematic coupling; inertial coupling; and angle of incidence effects.

The roll-coupling mechanisms have been with aviation from the very first, but have only become a problem with the advent of high speeds and jet aircraft; not because of characteristics of the power plants but because of planforms and mass distributions. In order to achieve the necessary high speeds, fuselages have become long and slender and wings small, with a low aspect ratio. This mass distribution is ideally suited for high performance and rapid roll capabilities, but has serious coupling problems at high roll rates. Since none of the contributing mechanisms can be isolated inflight, I'll try to lay them and their interrelationships out for you.

Kinematic Coupling

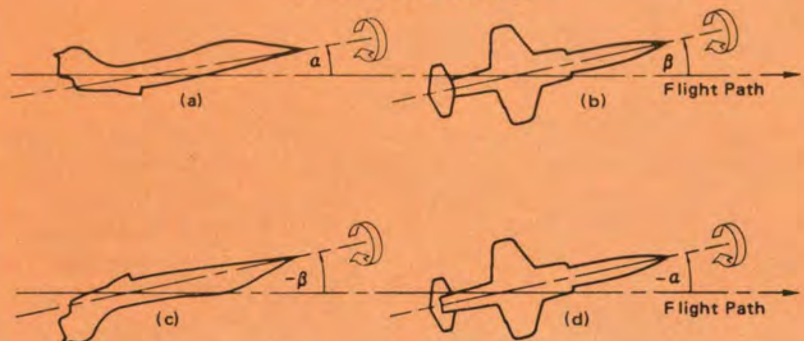
Kinematic coupling, as shown in Figure 1, is the simplest contributor to roll coupling.

As the airplane is rolled about its longitudinal axis from an initial positive angle of attack (a), the AOA is transformed into sideslip (B) after a quarter roll. As the roll continues, the sideslip is transformed into negative AOA at the inverted position, then into negative sideslip at the three-quarter point, and finally back to positive AOA after 360 degrees of rotation. As the roll continues, sideslip and AOA vary periodically with roll angle. This kinematic effect assumes that the airplane rolls around its longitudinal axis and neglects pitch and yaw stability moments which try to align the airplane with its flight path.

WHIFFERDILLS

continued

FIGURE 1
KINEMATIC COUPLING



Inertial Coupling

Inertial coupling may best be understood by first simplifying the airplane mass distribution into four equivalent masses – two large masses representing the fuselage and two smaller masses representing the wing (Figure 2).

For any given roll rate about the flight path, the fuselage masses are acted upon by centrifugal force and tend to pull away from the roll axis (flight path in this case). These forces are depicted in Figure 3.

The magnitude of this force couple increases with the square of the roll rate and is highly destabilizing.

FIGURE 2
EQUIVALENT MASSES

The wing masses similarly form an opposite stabilizing force couple, but are relatively weak in proportion to the destablizing fuselage-mass force couple of our long, slender airplane. Although it sounds as if our example airplane is unsafe to fly, fortunately, both longitudinal

FIGURE 3
DESTABILIZING YAW FORCES

(pitch) stability and directional (yaw) stability, which are normally quite high, act upon the airplane by trying to keep it heading into the relative wind. It is only with high roll rates that the destabilizing forces can overpower the normal aerodynamic stability and cause a roll-coupling yaw divergence.

Now that roll coupling is becoming clearer, the astute reader may wonder if coupling can be eliminated by making the wing mass effect (roll inertia) greater than fuselage mass effect (pitch inertia), as shown in Figure 4. The wing-mass force couple can now overpower the smaller fuselage-mass force couple and prevent the nose from yawing away from the flight path.

This approach does indeed eliminate the tendency to diverge in yaw, but unfortunately, no mass couple exists above and below the airplane which would oppose a similar divergence in pitch (Figure 5).

Actually, airplanes which have higher roll inertia than pitch inertia have long straight wings (high aspect ratio) and a relatively low roll rate capability. Therefore, even though their mass distribution precludes yaw divergence, their roll rate

FIGURE 4
STABILIZING YAW FORCES

capability is so low that pitch divergence never becomes a problem.

To place the whole mass distribution issue in perspective, a clean slatted F-4 has approximately six times more pitching inertia than rolling inertia. Even with full external wing tanks and three 500-pound bombs on each inboard wing sta-

FIGURE 5
DESTABILIZING PITCH FORCE

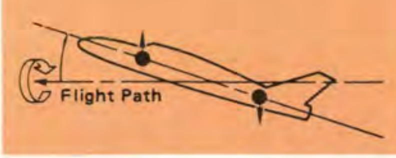


FIGURE 6
SPIN STABILIZED

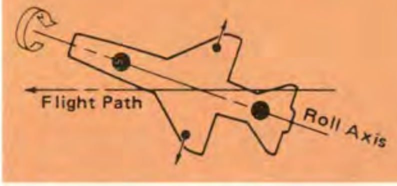


FIGURE 7
ANGLE-OF-INCIDENCE EFFECT

tion, the pitch inertia is still three times greater. The numbers for the Eagle are only slightly less; a clean F-15 has approximately five times more pitching inertia than rolling inertia. Even when loaded with three full external tanks, four Sidewinders and four Sparrows, the ratio is still three times as great. Therefore, inertial coupling can be a problem no matter what the loading.

What of our original example – the bullet? The bullet is spun well above the critical roll rate so that it is spin stabilized, rolling about its "fuselage masses." The inertial gyroscopic forces are highly predominant and stabilize its attitude, similar to the very rapidly rolling, hypothetically spin-stabilized airplane of Figure 6.

Occasionally, projectiles have been known to tumble; this occurs when the roll rate decreases to the critical rate which reinforces aerodynamic modes of motion until divergence occurs. This divergence is identical to the roll coupling divergence of a long slender rolling airplane except for the direction of approach to the critical roll rate.

Putting It All Together

Now that roll coupling is almost understandable, how can I, as fighter pilot extraordinaire, do consecutive 360 degree aileron rolls safely? Our above discussion suggests that we can if we roll at zero g, keeping the fuselage masses centered on the roll axis and their destabilizing force couple at zero. Wrong – for three reasons!

" . . . Even though rolling limitations may sometimes seem unnecessary, they do have a very firm grounding based on some very real problems . . ."

First, zero g does not ensure that these fuselage masses are on the flight path. (This is the angle-of-incidence effect, the last of the three contributors mentioned earlier.) Depending upon the angle of attack required for zero g and upon the fuselage mass distribution, the angle of incidence of these fuselage masses can be above or below the rolling axis, as seen in Figure 7. This may be most easily visualized in an airplane with a high vertical tail, possibly a high tail-mounted engine, and a low nose. Worse, with this hypothetical airplane, add in low angle of attack at zero (or negative) g and at high speed which further aggravates a negative angle of incidence below the flight path. These are some of the most conducive design and flight circumstances for a catastrophic roll-coupling departure!

Second, even if we could keep the fuselage masses on the roll axis longitudinally, it is impossible to keep the fuselage aligned directionally with the roll axis. Aerodynamic cross-coupling effects such as yaw due to aileron, yaw due to roll rate, yaw due to rudder, and about a dozen other minor lateral-directional aerodynamic effects combine to generate some sideslip. Further, as the airplane rolls, this sideslip becomes angle of attack, becomes opposite sideslip, becomes opposite angle of attack, etc., as these kinematic effects magnify and transform these small disturbances. No longer are the fuselage masses aligned with the roll axis, but are diverging from the axis, increasing the size of their destabilizing force couple.

Third, as the roll rate increases, these periodic variations of sideslip and angle of attack occur at the same frequency as the natural airplane directional and longitudinal

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TANKERS LIVE LONGER

BY BUDD PARRISH
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The value of the in-flight acoustic crack detection system (ACDS) for C/KC-135 aircraft.

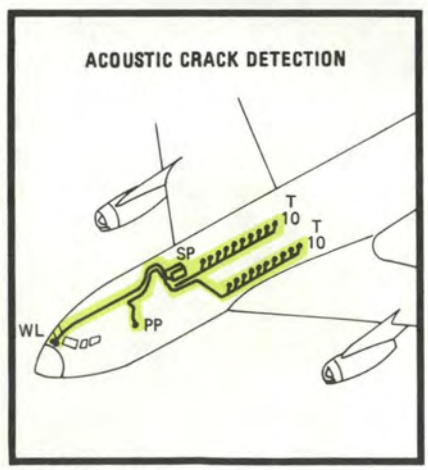
■ A unique nondestructive inspection system has been developed at Tinker AFB to detect unstable fracture of center wingskin panels in -135 series aircraft during flight. The system consists of twenty piezoelectric transducers bonded directly to the aircraft lower center wingskin and the Signal Processor module which monitors signals coming from the transducers. The Signal Processor module discriminates against non-crack signals and activates local and remote caution indicators when it detects the acoustic emission signature produced by unstable fracture in the wingskin.

With approximately 430 systems in service, and nine months of actual field experience, there is now sufficient data to provide a meaningful assessment of the advantages a system such as this offers the aircraft user.

Why the Need for In-Flight Crack Detection?

Prior to the last decade, structural designers thought the key parameter that characterized the ability of a material to withstand service loading was its ultimate tensile strength, and airplane designs were based on that parameter.

Recent studies in the field of fracture mechanics have found that unstable fracture can occur in the elastic region, at stress levels considerably below the ultimate strength of the material. These studies have developed a new material parameter, fracture toughness, which is a measure of the ability of a material to resist failure in the presence of a crack.



WL - Warning Light
SP - Signal Processor
PP - Power Panel
T - Transducers

Boeing designed the 707 model airplane for commercial passenger service and the KC-135 for a more severe service loading condition as a tanker for the USAF. In the lower wingskin of the 707, Boeing used 2024-T3 aluminum, an alloy which has only moderate ultimate strength, but whose fracture toughness is quite high. In an attempt to accommodate the higher structural loads to which the KC-135 would be subjected, the decision was made to use 7178-T6 aluminum alloy for the lower wingskin. 7178-T6 is a high performance alloy in terms of its extremely high load bearing ability per pound of material, but it shares with other exotic materials the fact that it has an exotic failure mode. 7178-T6 has a very low fracture toughness.

Fracture toughness – measuring the ability of a material to resist failure in the presence of a crack – is a very important parameter because all materials and their composites contain flaws. Tiny flaws such as cracks, notches, or defects in welds may be present in the material itself or may be introduced during fabrication and thus are built into the structure. As the structure undergoes repeated loadings, which leads to fatigue, these subcritical flaws may grow to the critical crack size for the material, stress level and service condition and become a running crack which produces unstable fracture.

Whereas the outer wing of the -135 functions as an integral fuel container and cracks in the skin are rendered detectable by the fuel leaks they cause, the center wing section of the airplane is a dry bay area – with fuel in bladder tanks – so that cracks do not cause fuel leaks and, therefore, go undetected.

A number of unstable cracks has been found in the KC-135 fleet since 1971. Those were cracks greater than three inches in length, and some were complete panel failures. Fortunately, fail safe design is incorporated in the lower wingskin of the KC-135 so that an airplane can withstand a complete panel failure as long as high wing loads are subsequently avoided.

In contrast, the commercial 707 fleet, with wing structure of 2024-T3 aluminum has had no panel failures.

Based on these facts, the USAF KC-135 Structural Advisory Group decided to initiate a program (now underway) to reskin the lower wing of the airplanes in the KC-135 fleet with 2024-T3 material. Since the reskin program was to require ten years, the Structural Advisory Group had to decide between two alternative interim measures to preserve flight safety until reskinning could be completed. They would choose either:

■ A repetitive physical inspection of the wing center section of all non-reskinned aircraft no less frequently than at semi-annual intervals. A major shortcoming of these periodic inspections is that a small stable crack could very well propagate catastrophically on the next flight following a physical inspection. Also, these two yearly inspections would require approximately 900 manhours per aircraft and cause each aircraft to be grounded for approximately 15 days per year; or,

■ An interim measure utilizing a special in-service crack detecting means to detect unstable crack growth in the lower center wing of all non-reskinned aircraft.

The Structural Advisory Group decided in favor of the in-service crack detecting system.

ACDS Production Program

■ The first installation was completed on 13 Mar 79 at Tinker AFB.

■ A total of 625 aircraft will be involved.

■ Approximately 500 installations have been completed to date (15 Jan 80).

■ Approximately 64,000 flight hours have been accumulated to date on various -135 configurations.

■ Cost is approximately $10,000, per airplane for hardware package, installation and technical data.

The ACDS has undergone extensive laboratory testing and refinement. The present configuration has never failed to detect an unstable crack in the laboratory environment. By design, very high sensitivity has been selected to ensure that an unstable crack will be detected in an operational environment. As a consequence of the high sensitivity required to reliably detect center section cracking, the occasional occurrence of a false alarm cannot be avoided.

Early in the production program we learned that incidents involving crack warning indications tended to follow in the wake of the field team installing systems. Most of the problems we had generally occurred within three weeks after the time the using command received the airplane following ACDS installation. We learned that once these infant problems were cleared, and the operational people became familiar with the system, things settled down and incidents became very infrequent.

During the initial nine months of the program, we had 24 false crack indications. The rather thorough investigation which is initiated following an incident determined that two of the earliest incidents were caused by a design deficiency – which was very quickly corrected by design change – and 16 others were caused by equipment failure, faulty installation or operator unfamiliarity. We were unable to relate causes of the remaining six incidents to defects in equipment, installation or procedures, so physical inspection of the wing center sections of those six airplanes was required. In all six cases, no evidence of cracking could be found and the aircraft were returned to flight status, their signal

TANKERS LIVE LONGER continued

processor modules replaced by new ones.

We are continuously working to minimize the number of false indications and their operational impact. As a result of our sensitivity to user experience and feedback from the field, we have made a modification in the equipment design and have issued several changes to improve the clarity and completeness of maintenance and operational data in the T.O.s.

Estimating the Value of the ACDS

1. Analyze actual data resulting from the first nine months of field experience with the ACDS.
2. Project, from the nine month data, aircraft inspection manhour and downtime estimates which may be expected to result from use of the ACDS assuming 625 aircraft equipped with ACDS for one full year.
3. Project aircraft inspection manhour requirements and aircraft downtimes which would result for 625 aircraft for one full year if ACDS were not available.
4. Compare the inspection manhours and aircraft downtimes arrived at by both methods extended over the nine year program life to give an estimate of the value of ACDS to the Air Force.

Conclusions

The data show that over the life of the program, the ACDS:

■ Gives the equivalent of having 13 additional aircraft in inventory by saving 42,858 days of aircraft downtime

FIGURE 1
Nine-Month Field Experience

Nr ACDS Installed	430
Total Flight Hours (Approx)	48,375
Total Incidents*	24
Flight Hrs/Incident (Approx)	2015.6
Total Inspections Performed	6
Flight Hrs Per Inspect (Approx)	8,062.5
M/H Expended For Insp (Approx)	2,500
Avg M/H Per Insp (Approx)	417
Average Days A/C Grounded Due To Incident	4.6
Total A/C Days Lost Due To Incidents (Including Inspections)	110.4

*An Incident is defined as a crack warning indication regardless of cause.

FIGURE 2
Projected aircraft inspection manhour and aircraft downtime estimates assuming 625 aircraft equipped with ACDS for one full year

Nr ACDS Installed	625
Projected Total Flight Hrs	187,500
Projected Flight Hrs/Incident	4,030*
Projected Total Incidents	47
Projected Inspections Required	19
Projected Flight Hours Per Insp	9,675
Projected M/H Per Insp	417
Projected M/H For Insp	7,923
Projected Average Days A/C Grounded Due To Incident	4.6
Projected Total A/C Days Lost Due To Incidents (Including Inspections)	216

*Flight hours per incident will increase due to clearing ACDS of infant mortality failures.

FIGURE 3

Periodic inspection manhour and aircraft downtime requirements without ACDS for 625 aircraft for one full year

The alternative to the ACDS requires two center wing inspections per year for each C/KC-135 A/C. These two yearly inspections would require approximately 900 manhours per aircraft and cause each aircraft to be grounded for approximately fifteen days per year.

Total M/H Per A/C Per Year For Insp	900
Total M/H Per Year 625 A/C	562,500
Total Downtime Per A/C	15 days
Total Downtime 625 A/C	9,375 days

FIGURE 4

Total program manhour and downtime projections for aircraft equipped with ACDS vs aircraft without

Program Year	Number of Aircraft	Number of Inspections Required Without ACDS	Number of ACDS Incidents Expected	Number of Inspections Required With ACDS
1st	625	1,250	47	19
2nd	550	1,100	42	17
3rd	475	950	35	14
4th	400	800	30	12
5th	325	650	25	10
6th	250	500	20	8
7th	175	350	12	5
8th	100	200	7	3
9th	25	50	3	1
TOTAL		5,850	221	89

Without ACDS

M/H required for inspection = 2,632,500
(450 M/H per A/C x 5,850 insp)

Total A/C days lost = 43,875
(7.5 days per insp x 5,850 insp)

With ACDS

M/H required for inspection = 37,113
(417 M/H per A/C x 89 insp)

Total A/C days lost = 1,017
(4.6 days per incident x 221 incidents)

■ Saves 2.6 million maintenance manhours or 1,260 man years

■ Gives the Air Force continuous monitoring of the fracture susceptible wingskin panels

■ Will permit field units to perform occasional inspections for cause rather than imposing on them a heavy burden of routine periodic inspections.

ACDS offers significant advantages at all levels:

■ To the Air Force, it will identify the particular aircraft which develop serious structural damage so that they can be repaired and thus make it possible to keep the vast majority of the fleet continuously in service.

■ To the managers, it provides a tremendous improvement in airframe availability

■ To the flight crews, it provides increased flight safety and a great potential to save lives.

■ To the maintenance community, it provides relief from the burden of frequent, routine periodic inspections.

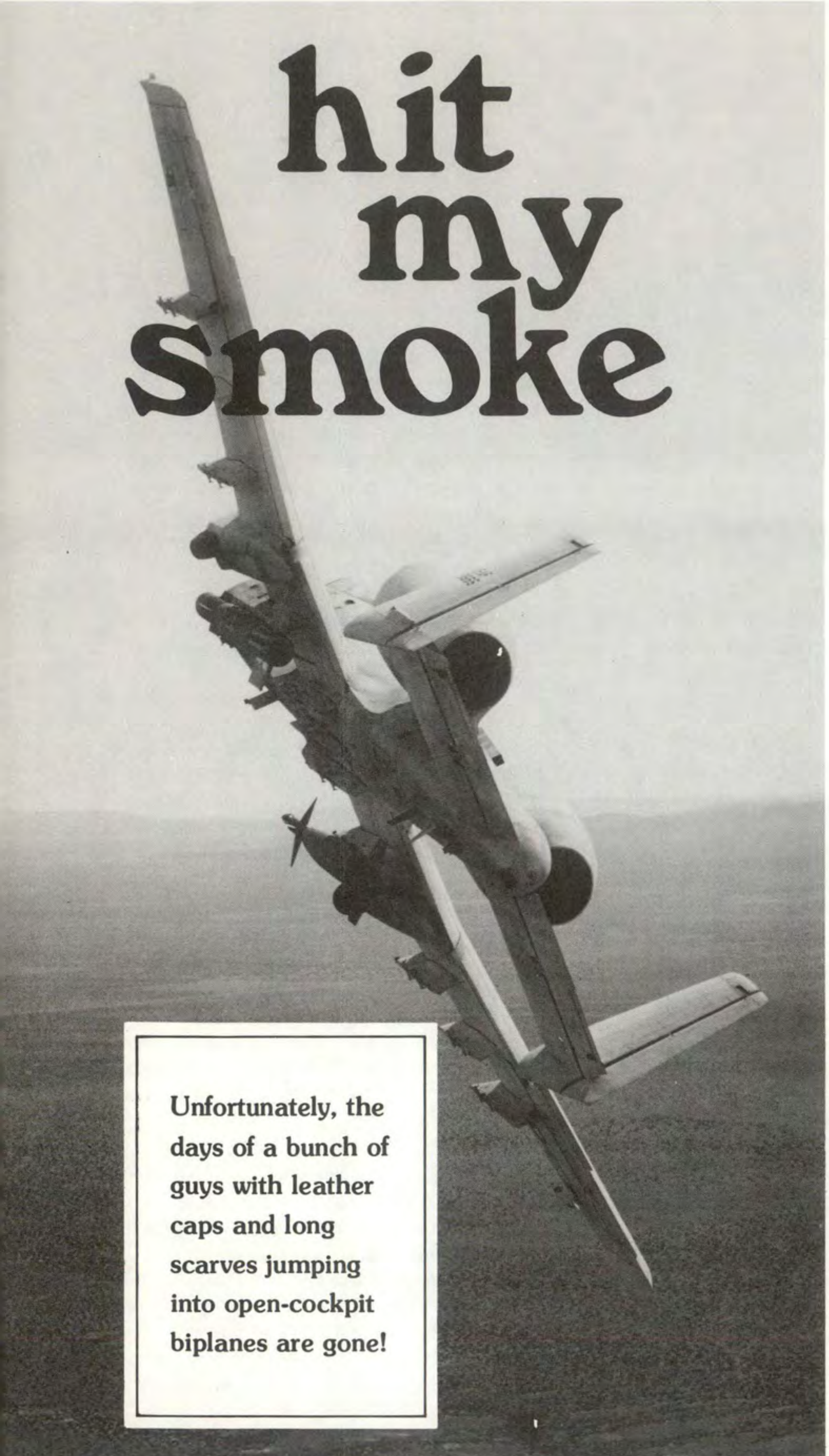
Even if it were possible to reduce the number of manhours per inspection to two-thirds, the value used in this projection through experience gained by application of a learning curve, the manhour savings that result from the use of ACDS would still be substantial.

■ Crack detection systems designed to monitor stress critical areas of military and commercial airplanes may soon begin to play a key role in flight safety.

■ With development, the C/KC-135 ACDS can be adapted to provide flight safety for other aircraft in the Air Force inventory experiencing similar structural problems.

■ OC-ALC has the facilities and expertise to assist in development of Crack Detection Systems for aircraft applications in other commands where equally large cost savings may be effected. ■

hit my smoke



Unfortunately, the days of a bunch of guys with leather caps and long scarves jumping into open-cockpit biplanes are gone!

MAJOR DAVID V. FROEHLICH
Directorate of Aerospace Safety

■ In the old days when the friendly FAC issued that invitation and we started down the chute, we felt that we had as much going for us as was possible to do! Consistent with time available, crews target-studied thoroughly, preflighted well and flew smart. In combat, there was little room for error, because the gunners, SAM launchers and MIG drivers didn't honor the "knock it off" call. What I have a hard time comprehending is why crews in peacetime do *not* appear to prepare and train like they did prior to combat!

To go into a combat environment, you want to be well-schooled, thoroughly and realistically trained and well armed. You will fly and fight in combat as you have practiced in peacetime! Sure, you will add such intangibles as judgment, experience and the age-old "pucker-factor," but even those are based to a certain extent on your pre-mission preparation.

The days of a bunch of guys with leather caps and long scarves jumping into open-cockpit biplanes are gone! (Unfortunately) Not to say that the good sticks and top-guns don't have a quotient of "seat-of-the pants" skills and intuition, but they are also "book folks!" The mission is too complex, the machines too fast and intricate, and the scenarios too rapidly developing for aircrews to rely completely on "golden hands," "seat-of-the-pants skills" and "a quick eye." The crews that are consistently on top add *portions* of those individual traits to a good solid foundation of machine/mission knowledge, preflight planning/briefing and smart, *disciplined* flying! That combination is deadly—for the bad guys!

Anyone who reads that formula and complains about taking the initiative away from the crew, not letting the pilot use judgment, etc., is just not in tune with today's missions. There is more need and latitude for aircrew judgment in today's missions than ever before! The people who don't admit that are the ones who are so balled up in *fighting* the rules, regs and "the system" that they don't have the time or energy left for initiative or judgment. Examples—rolling off the perch to smoke a simulated bad guy on the ground is not the time for mental hassling over weather minimums, switch positions or ROE (Rules of Engagement) type problems. Tone on and doors manually opened is not the auspicious moment for an intra-crew "discussion" of parameters, procedures or responsibilities! "On course, on glide path, approaching minimums," on a partially obscured, 200′ yuk day, should not be the occasion for confusion about "what happens if I don't see the concrete." Those are the situations that call for judgment, experience and insight, but also require that the operator(s) has the procedures, rules and equipment parameters so prebriefed and "second-nature" committed that there is no question about that input to his decision process.

No individual will ever argue that "the book" is perfect or covers every situation. What I will stand behind is that 99.97% of the operational procedures, limitations and restrictions have some good basis of establishment. Most were written or derived from combat experience or extensive peacetime practice/study. Therefore, the key to survival in training and also to approaching excellence is to arm yourself with a thorough (and current) knowledge of directives, limitations and procedures, and then add your own skill, intuition and judgment. That is how experienced crews live long enough to become experienced!

Modifying tech data or procedures lowers your survival percentages.

Notice I didn't say "add your own interpretation of the rules or procedures." If you have heartburn about the adequacy, accuracy or necessity of procedures, use the squadron and/or safety channels to get them changed. Don't be the one who a witness to the mishap board quotes as having said "That procedure doesn't work for me, so when I fly I use . . ." Modifying tech data or procedures lowers your survival percentage!

There are two other points worth rehammering! First, all of the skill, knowledge and intuition is wiped off the slate by the crew that takes a good-running machine and over-presses or over-commits. Excessive "win-itis" and the "fear of bad numbers" have followed lots of good crews into a smoking hole! The key word is "excessive!" Crews and supervisors need to be watchful for telltale signs of pressing or over-committing. Another worthy reminder goes hand-in-hand with the "press-itis" problem. That is the deadly tendency to stay with a sick machine too long! Looking back at '79 mishap summaries, I find the following statements cropping up over and over:

"The pilot delayed ejection until outside the safe ejection envelope and was fatally injured."

"Ejection was attempted outside the ejection envelope, and the pilot was fatally injured."

"A dual sequenced ejection was initiated, but out of the ejection parameters. Two fatal."

The point—there are tested figures for ejection systems and correlated minimums in your dash-one and ops procedures. Use them! When the maneuver or machine reaches the unacceptable magic number, float down and walk home. If your backside is not rocket or cannon-shell equipped, you don't have the float down option; therefore, your judgment parameters and minimums are different. Regardless, don't wait until too late!

I've said it before, but reading 1979 summaries of 94 Class A mishaps with 83 destroyed aircraft and 77 fatalities prompts me to repeat: Knowledge plus training equals skill. Skill plus discipline equals professional, safe mission accomplishment and survival. You can't win if you don't survive the fight! ■

SAFETY AWARDS for distinguished contributions during 1979

SECRETARY OF THE AIR FORCE
SAFETY AWARD
Major command that flies more than 2% of the total USAF flying time.

MILITARY AIRLIFT COMMAND

General Robert E. Huyser, Commander in Chief, MAC, accepts trophy from Dr. Hans M. Mark, Secretary of the Air Force. The MAC Class A mishap rate equaled the lowest rate in seven years. Airlift and air rescue operations saved 500 lives during response to worldwide disasters. Nuclear, ground and explosives safety programs were equally effective.

SECRETARY OF THE AIR FORCE
SAFETY AWARD
Major command with a small or no flying mission.

ALASKAN AIR COMMAND

Highest award for an effective safety program is presented to Lt Gen Winfield W. Scott, Jr., Commander, Alaskan Air Command, by Dr. Hans M. Mark, Secretary of the Air Force. The command had no Class A aircraft mishaps and no on- or off-duty ground mishap fatalities. Despite harsh environment there were no Class A or B weapons mishaps or injuries.

DIRECTOR OF AEROSPACE SAFETY
SPECIAL ACHIEVEMENT AWARD

For outstanding safety achievements, the Air Force Academy was selected for this award. The USAFA completed 1979 with no ground mishap fatalities and a government motor vehicle rate far below Air Force average. It is the first organization to win the Director of Aerospace Safety Special Achievement Award.

United States Air Force Academy

THE MAJOR GENERAL
BENJAMIN D. FOULOIS
MEMORIAL AWARD

Presented by the Order of Daedalians, the National Fraternity of Military Pilots, the Foulois Award recognizes the MAJCOM with the most effective flight safety program for the preceding year. AFRES reduced Class A mishaps to four and had no Class B mishaps, while performing an extremely varied mission with many different aircraft types.

Air Force Reserve

Unlucky SEVEN

1 2 3 4

MAJOR MICHAEL D. BLANCHARD
Directorate of Aerospace Safety

■ The crew was preparing the "heavy" for flight. Normal preflight operations were progressing with the usual snags – (hydraulic fluid spilled in wheel well, dzus fastener loose on panel) being corrected by the ground crew.

As the crew was accomplishing the interior cockpit check and turned on the aircraft air conditioning system, a dusty odor was noted throughout the crew compartment. The pilot told the ground crew about the problem and the crew chief replied that the air conditioning system had been worked on by maintenance after the last flight. The pilot then assumed the odor was probably residual effects from the maintenance actions.

Preparations for flight continued and the aircraft was taxiied out to the runway for takeoff. There was a delay at the end of the runway for maintenance to work a bomb-nav system problem. During this delay, the dusty odor continued, so the pilot reviewed the dash one for catalytic filter failure. As they waited a little longer, they noted some particles coming out of the air conditioning vents. Environmental maintenance personnel were called to check out the situation and sure enough, the catalytic filter had failed.

By this time, three of the crewmembers were experiencing eye irritation caused by the particles coming from the air conditioner, so the pilot requested the flight surgeon come out to the aircraft to help evaluate the situation. The pilot discussed the possibility of flight with the flight surgeon. The Doc advised that the dust could cause a problem if it continued to come through the vents. In addition, the dash one contains a warning which states: to avoid possible harmful effects of breathing the powder when filter failure occurs during flight, the crew must go on 100% oxygen. The filter was replaced, and the pilot ran up engines 3 and 4 to 85% to clear the dust particles from the system. After the run up, particles could no longer be seen coming through the vents so the pilot determined the system was repaired and elected to continue the mission. That was the first link in the inevitable chain.

Immediately after takeoff, all four main gear failed to retract. Established procedures failed to correct this problem so the pilot elected to fly the mission with the gear down. Due to the increased drag, this would require significantly

5 6 7

higher power settings for the remainder of the mission. The second link was then attached to the chain.

The high power settings dictated by the gear drag caused excessive air flow through the air conditioning vents. This began to stir up the dust particles that had previously been disseminated by the filter failure problem. As the crew began to smell the dusty odor they went on 100% oxygen. Long hours of wearing a mask and breathing 100% oxygen is uncomfortable and tiring. Fatigue was weaving its insidious effects into the mishap sequence, another link in the chain.

After level off, the pilot could not engage the autopilot. That may not sound like a biggee to a fighter jock, but on a 10-hour misison it is a real drag. Again, not cause for abort by itself, and the pilot elected to continue the mission. Link nr 4.

When the pilot began to refuel, it was obvious that MRT would be required to maintain position on the tanker. This, of course, increased the problem of particle dispersion throughout the cockpit. Several crewmembers complained to the pilot of headaches, but the pilot attributed them to in-flight tension. Being a strong believer in mission accomplishment, the pilot elects to press on. Link nr 5.

One and a half hours later, the crew finally reached the low level of flight. They are fatigued but still determined to complete that mission. Link nr 6.

The navigator calls for the crew to descend 1,500 ft at turn point Delta. The radar is setting up for his bomb run and doesn't crosscheck the map. The copilot has a headache and doesn't cross-check his map. The weather is IFR. The pilot descends 1,500 feet. The map calls for the descent at point Echo not Delta. Last link – nr 7.

The aircraft impacted a mountain. All crewmembers were killed on impact. No ejections were attempted.

This crash did not occur. In the actual case, the pilot broke the chain at link nr 5 and aborted the mission to return home safely.

The point is that aircraft mishaps usually occur as a chain of events which act in concert to produce a catastrophic result.

Crewmembers must be aware of this chain of events syndrome and use good judgment to prevent the chain from reaching the critical link. ■

X-COUNTRY NOTES

TA NOTES

■ **MARSHALLING** – Besides what the book says, there are some items that can make the aircrew taxi task a lot smoother and safer!

Marshallers need to be far enough back from the desired parking spot that the crew doesn't lose sight of them below a canopy bow or the nose of the aircraft. If the pilot can't see your signals, you aren't much good to him. Dawn, dusk or when it's dark due to weather, think about the visibility and when you want to switch from paddles to lights or vice-versa. To pilots taxiing in the rain on a dark afternoon, the flashlights may be a lot more help than paddles.

Have some sympathy for the poor pilot as he guides his multi-dollar machine in or out of your dark and sometimes busy, crowded ramp. Everything may look super clear, safe and familiar to you as the marshaller, but from the cockpit it may not appear quite so safe.

REMEMBER – the pilot buys it if a power cart, fire extinguisher, pickup truck or other air machine magically jumps out and smacks his wingtip. If tolerances are close, obtain wing walkers and let the taxiing pilot know that you are watching the close objects. One base back East has a TA marshaller that really moves around, does gyrations and gives thumbs-up signals to each object as you pass. Maybe that's the extreme, but I sure feel that he's taking good care of my machine as I bring it in or out of his ramp. We play "you-bet-your-wings" often enough without having a dumb taxi crunch mishap.

FOD – The transient ramp is a very vulnerable place for FOD to collect because of the variety of aircraft and unstandardized type of operation. Be especially watchful for nuts, bolts, rocks, checklists, rags, fasteners, panels and leftover crewmembers. Don't get in the habit of dropping junk in the back of the TA vehicle or laying objects on the power cart. Wind or jet-blast could make them FOD for a hungry engine, and that is another very unimaginative way to spend tax dollars.

PARKING – At some of the locations where high winds are a problem, keep in mind the parking of the machines *into* the wind. More and more with crowded ramps and limited service, you can't afford to be towing airplanes around to head them into the wind to get them started. There are some airplanes still around that can't start with lots of wind blowing up their tailpipes. Just worth mentionin'!

CREW NOTES:

WATCH YOUR POWER – On the last trip out we saw lots of transient folks in numerous locations taxi in and out with high power. Have a little extra thought about blowing over stands, ladders, power units, chocks, fire extinguishers, etc. Not only is that a good way to hurt someone, but also an opportunity to FOD engines, flight controls and/or cockpits of other aircraft on the ramp. I watched a T-39 pull out of parking, leave the power way up and blow a set of chocks out from under the wheels of another aircraft and into the bushes next to Base Ops. He wasn't the only guilty one because ten minutes later an F-4 pulled out with the levers way forward and blew over a small maintenance stand just missing a wingtip. Watch your power!

TAKE TIME WITH THE FORM – Most TA folks will meet you with some type of "Transient Aircraft Servicing Request" form when you deplane at a strange airpatch. We've noticed (and I've been guilty at times) that a lot of aircrews just sign the form on the run and don't pay much attention to it. Word to the wise! At places with lots of traffic, that form is the aircrew's best insurance for fast and accurate servicing of their aircraft. Spend some time looking at the form, checking the items marked for service. A little extra time may preclude a wrong fuel load or a missed servicing requirement.

FLIGHT PLAN REMINDERS – This trip I really fell on my sword twice when I rushed thru a last minute flight plan change and filed a J-route which (had I read the small print) turned out to be a one-way route at that time period. POINT – We have packed more info into the FLIP books and charts than the average mental computer can sort in a hurry. Spend an extra few minutes after the 175 is done to check your route, the IAF for your destination and the times and altitudes. Also, if there are any oddball requirements or requests, spend an extra moment when you file to make sure there is no confusion. Those few extra minutes in Base Ops can save you lots of minutes on the end of the runway with the engines running and the gas gages winding

REX RILEY
Transient Services Award

MAJOR DAVID V. FROEHLICH • Directorate of Aerospace Safety

down.

NOTAM BLUES – Not only don't forget to check the NOTAMS, but also the hourly updates when you're planning or stopping thru. Also – look at the "effective" expiration time on the hourly update. We found three places with "out-of-date" updates. The new ones had been sitting in the basket in the weather det for as long as 45 minutes in one case. If the effective time has passed on the update, query the dispatchers. You could depend heavily on a simple one line on the hourly update like "RWY03 BAK 12B OUT." Avail yourself of all the most current information you can while still on terra firma!

WARNING – In the interest of good, safe, smooth service for all, let your destination know you are coming. If departing a civil field, call FSS and activate your flight plan so your inbound will be passed to your destination. Pick up the phone and call "destination ops" to advise them of your arrival time and any special requirements – like fuel for two four-ships of F-15s. Call PTD on the way in and update your ETA and requirements. Good service depends on good communications between all agencies. Folks can give you a much better turn if you don't drop a bombshell of surprises on them!

RETAINED AWARDS

SEYMOUR JOHNSON AFB – A bunch of snow gave them fits a few weeks ago, but they should be unburied. Their transient ramp is a little narrow but service is good and facilities are O.K. Lots of traffic around and a few MOA's make this another sporty flying area.

McCHORD AFB – Best in the West this trip. They get their share (and somebody else's) of rainy weather and low ceilings, but these folks work hard at taking good care of aircrews. Base Ops (part of an old "mole-hole") has been refurbished since my last visit and facilities are now first class. Personnel are conscientious and helpful, and transport, quarters and TA assistance are all top-notch. Keep up the super work!

WELCOME BACK

DOBBINS AFB – Best in the East this trip. Dobbins has been on the Rex Riley list before and we are glad to welcome them back. We weren't able to spend the night but the Base Ops folks, weather personnel and TA pros really blew our socks off. They were as impressive and professional a bunch as we've seen in quite a while. It was a pleasure!

IN GENERAL

We are still seeing improvements. Attitudes are more toward smooth, safe service than ever before. At many locations, folks away from the actual flightline are starting to realize what a large part they play in providing safe, pleasant stays for transients. Our thanks go out to the billeting, inflight kitchen and transport folks that are really in their pitching!

Grumbles and gripes, or pats and praises, fill out an aircrew questionnaire – leave it with Base Ops and forward a copy to: Rex Riley, AFISC/SEDAK, Norton AFB, CA 92409. ■

LORING AFB	Limestone, ME
McCLELLAN AFB	Sacramento, CA
MAXWELL AFB	Montgomery, AL
SCOTT AFB	Belleville, IL
McCHORD AFB	Tacoma, WA
MYRTLE BEACH AFB	Myrtle Beach, SC
MATHER AFB	Sacramento, CA
LAJES FIELD	Azores
SHEPPARD AFB	Wichita Falls, TX
MARCH AFB	Riverside, CA
GRISSOM AFB	Peru, IN
CANNON AFB	Clovis, NM
LUKE AFB	Phoenix, AZ
RANDOLPH AFB	San Antonio, TX
ROBINS AFB	Warner Robins, GA
HILL AFB	Ogden, UT
YOKOTA AB	Japan
SEYMOUR JOHNSON AFB	Goldsboro, NC
KADENA AB	Okinawa
ELMENDORF AFB	Anchorage, AK
PETERSON AFB	Colorado Springs, CO
RAMSTEIN AB	Germany
SHAW AFB	Sumter, SC
LITTLE ROCK AFB	Jacksonville, AR
TORREJON AB	Spain
TYNDALL AFB	Panama City, FL
OFFUTT AFB	Omaha, NE
NORTON AFB	San Bernardino, CA
BARKSDALE AFB	Shreveport, LA
KIRTLAND AFB	Albuquerque, NM
BUCKLEY ANG BASE	Aurora, CO
RAF MILDENHALL	UK
WRIGHT-PATTERSON AFB	Fairborn, OH
CARSWELL AFB	Ft. Worth, TX
HOMESTEAD AFB	Homestead, FL
POPE AFB	Fayetteville, NC
TINKER AFB	Oklahoma City, OK
DOVER AFB	Dover, DE
GRIFFISS AFB	Rome, NY
KI SAWYER AFB	Gwinn, MI
REESE AFB	Lubbock, TX
VANCE AFB	Enid, OK
LAUGHLIN AFB	Del Rio, TX
FAIRCHILD AFB	Spokane, WA
MINOT AFB	Minot, ND
VANDENBERG AFB	Lompoc, CA
ANDREWS AFB	Camp Springs, MD
PLATTSBURGH AB	Plattsburgh, NY
MACDILL AFB	Tampa, FL
COLUMBUS AFB	Columbus, MS
PATRICK AFB	Cocoa Beach, FL
ALTUS AFB	Altus, OK
WURTSMITH AFB	Oscoda, MI
WILLIAMS AFB	Chandler, AZ
WESTOVER AFB	Chicopee Falls, MA
McGUIRE AFB	Wrightstown, NJ
EGLIN AFB	Valpariso, FL
DOBBINS AFB	Marietta, GA

The Good Samaritans

On a number of occasions Air Force aircrews have been called upon to assist other aircraft in an emergency. The following article describes a cliff hanger of an incident in which an Air New Zealand crew saved an American pilot lost over the South Pacific. Not only does it make great reading, the article reminds us of some mostly forgotten techniques that may still be of use in a situation where our modern electronic wizardy can't hack it.

■ It was a "shorthaul" DC-10 flight, TE103, Nadi to Auckland, scheduled to take three hours. Soon after leaving Fiji at about 5:30 PM on December 21, however, Captain Gordon Vette received a call on HF from ATC, Auckland, which was to stretch his flight time to nearly seven hours.

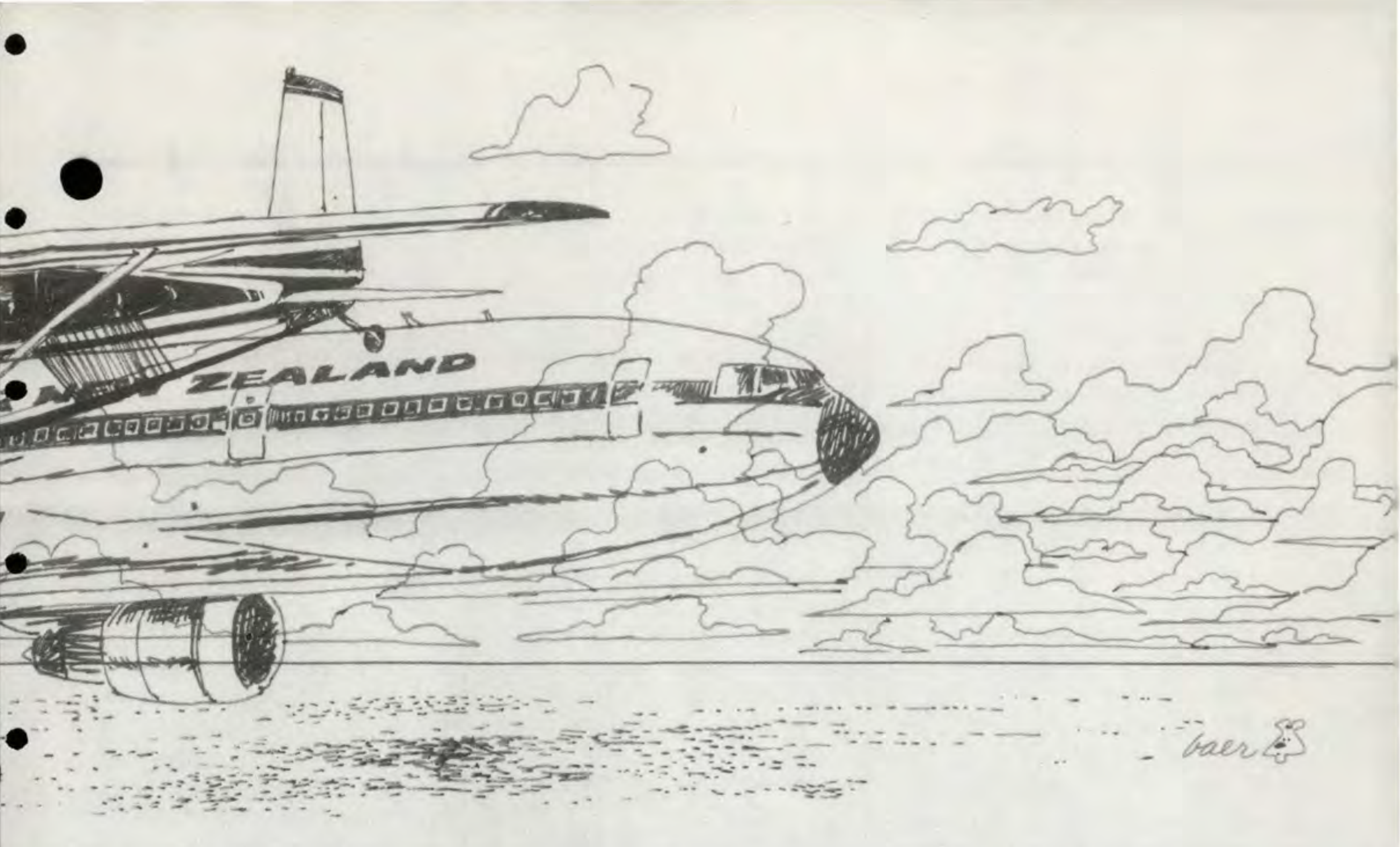
An American-registered Cessna was overdue at Norfolk Island on a flight from Pago Pago. Would Captain Vette contact him and assist if possible?

Requesting the last HF frequency used by the Cessna pilot, Captain Vette called the Cessna on this and eventually got a response from a rather worried young American, J. E. Prochnow of Trans Air, Oakland Airport, California, who was on a delivery flight to Australia. Question and answer revealed that he had cause for worry— he was two hours overdue on his ETA for Norfolk and he estimated he had 2½ hours' fuel left.

He didn't know where he was and faced a real threat of ditching and being lost in the Pacific if the DC-10 crew couldn't find him. With a life clearly at stake, Captain Vette and his crew began to contemplate the ways in which they might— just might— locate a small aircraft lost at 7,000 feet over an infinity of ocean. There followed a prolonged and frustrating "needle-in-a-haystack" search carried out in consultation with the Auckland search and rescue center where Bruce Millar was coordinator.

The first piece of good fortune for Mr. Prochnow lay in the fact that the DC-10 carried only 88 passengers but had a heavy fuel load. It had the endurance, therefore, for a fairly lengthy search. An RNZAF Orion, alerted to take off from Whenuapai would take some time to reach the search area. A second factor was that the DC-10 has automatic navigation and its position was, therefore, known at all times without need for calculation.

Step one in the search was to request the Cessna pilot to call periodically on the emergency VHF frequency 121.5 MHz. On the HF communication he could be nearby or thousands of miles away. But as soon as the DC-10 had him on the shorter range VHF there would be some idea of his distance away. Captain Vette calculated that with the Cessna at 7,000 feet and the DC-10 at 33,000 feet, VHF contact would be established when they were at



most 190 to 230 nautical miles apart.

In due course the Cessna came up on 121.5 – and the area in which it could be was reduced to something approaching 100,000 square miles.

The good news was passed to the Cessna together with the advice that there were two navigators aboard the DC-10 to work on the problem. Malcolm Forsyth, a DC-8 first officer traveling as a passenger in the DC-10 and, like Captain Vette, a licensed navigator, had come forward to help.

Captain Vette gave the Cessna pilot various radio station frequencies to tune to, hoping for a quick "fix" of the Cessna's position. He plotted the resultant bearings received from the Cessna and found they didn't make sense – in fact they put the Tauranga radio station north of the Cessna, something it manifestly wasn't.

It was apparent the Cessna's ADF was at fault, with the needle giving false readings.

"The next thing I said to him was to steer direct into the sun while I did the same. I compared our two magnetic headings, and it was apparent that he was out to my left just slightly," said Captain Vette afterwards.

"We decided the sun was the only way we could get a reasonable idea of his position. We needed the bearing and altitude of the sun from his position compared with our own."

"The trouble was neither of us had a sextant to make the comparison. I seemed to recall that a clenched fist at arm's length represented about 10 degrees, and a finger was a little more than a degree-and-a-half," said Captain Vette.

"So I told him to put his arm out and measure the number of fingers between the center of the sun and the horizon. I did the same and it appeared we had about a 3 degree sun altitude difference – something around 180 nautical miles, with him closer to the sun than me."

The problem then was to ensure the Cessna pilot would spot the much larger DC-10 once it was in his immediate area. Sighting the small aircraft from the DC-10 would be more difficult. Captain Vette had already made a turn to discover that the DC-10 was leaving no contrail, and even a change of altitude did not produce one.

"I decided that if we got into the vicinity of the Cessna, I would "paint" a contrail with a fuel dump. This would cost me 2½ tons of fuel for every minute I let the dump continue," Captain Vette said.

He flew towards the area in which he calculated the Cessna was and when he estimated the Cessna was close, he told the Cessna pilot to turn his tail to the sun while he headed the DC-10 into the sun and told the lost pilot they should be heading straight towards each other.

Then he did a two-minutes fuel dump but, disappointingly, the Cessna pilot could not see it. Another fuel dump should have painted a line 30 miles long in the sky, but again the lost pilot couldn't see it.

It was difficult to understand but,

on back-plotting, Captain Vette estimated he was probably almost directly above the Cessna when he did the fuel dumping.

By this time there was considerable concern on the DC-10's flight deck for it appeared the lost pilot was going to have to ditch alone somewhere in the Pacific. What to do next?

Sunset was approaching, and Captain Vette asked both Norfolk Island and the Cessna pilot to report their exact times of sunset to him. By comparing the two times, he was able to determine whether the Cessna was east or west of Norfolk. This seemed to put the Cessna about 5.6 degrees to the east of Norfolk.

This tallied with the DC-10's original estimates of his longitude and also seemed to tie in with the oral "boxing in" technique Captain Vette had been using on the VHF – a time consuming method involving turning when the Cessna's 121.5 signal faded and traversing a long radius when it came back to gradually pin down the Cessna's area of probability.

At 0815Z the Cessna's signal was lost but Captain Vette made a 90 degree turn left and picked it up again at 0825Z. He now headed for position 30S 177E and told the Cessna pilot, whose signal was now very strong, to circle and look for his powerful strobe lights.

Then, at 0902, the Cessna pilot reported sighting what appeared to be a surface light. Captain Vette told him to fly towards it and report its heading (310 degrees) but to make sure quickly that it wasn't a star low on the horizon.

The Cessna pilot had now exceeded his original endurance estimate and if the light proved to be a ship he might well be able to save his life with a ditching in the sea.

He reported the light was getting closer, indicating it was not a star, and then reported he was over some type of vessel. Captain Vette told him to circle the vessel, flashing his landing lights to attract attention, and to give a description of the vessel. From this description, the vessel appeared to be an oil rig and there was confirmation when the Cessna pilot reported two tugs ahead of it.

It was the Penrod rig, en route from New Zealand to Singapore.

From the Marine Division in New Zealand, part of the search organization, Captain Vette was given 119.1 as the Penrod's radio frequency and 31S 179.21E as its position. It was apparent that the Cessna would have to ditch, since this position was too far from any land. And indeed, the Penrod rig had already hove to and was launching a boat.

The Penrod position given, however, conflicted with the fade pattern and estimates calculated on the DC-10 flight deck. Captain Vette, therefore, called for a position confirmation direct from Penrod. This was given as 31S 170.21E – within 150-160 miles of Norfolk. It was just about the position where the fuel dump had been made earlier.

This put Norfolk Island just within range on the new endurance figure given from the Cessna, so Captain Vette gave the pilot the choice of ditching or taking a heading from the DC-10 for Norfolk.

The response from the Cessna was emphatic. The sea looked cold and dark; a heading for Norfolk please.

Captain Vette passed a heading of 290 degrees magnetic to the Cessna and told the pilot he would bring the DC-10 down to 10,000 feet and overtake the Cessna on its starboard side.

Even with landing lights on, the Cessna was difficult to see, but the DC-10 crew picked them out to the delight of their 88 passengers who had been kept informed through each phase of the hunt.

"We tucked him in behind, clear of our jet wash, and led him directly to Norfolk," Captain Vette recalled.

Since he could not slow below 200 knots he told the Cessna pilot to follow his strobe lights and to report immediately if he lost them, whereupon the DC-10 would circle back.

This didn't prove necessary, although the DC-10 forged ahead. It was overhead Norfolk when an Orion from New Zealand joined the Cessna with 40 or 50 miles to run, and led it in.

The last act was for Captain Vette to inform his passengers that the Cessna had made it on almost dry tanks, and to set course for Auckland where he landed at 1:09 AM local time – just 3 hours 54 minutes late.

The search was a team effort by the DC-10's flight deck crew, supplemented by Malcolm Forsyth, and Captain Vette commended them in a special report to Air New Zealand as well as the cabin crew under Chief Purser Paul James who worked several unexpected hours at keeping the passengers happy and informed.

While Captain Vette and First Officer Forsyth were working on ways of locating the Cessna's position, First Officer Arthur Dovey and Flight Engineer Gordon Brook carried a continual critical work load.

"The fact that they were such exceptional airmen helped a great deal," said Captain Vette.

(It occurs to us that many of the old navigational and piloting "dodges" may well have been forgotten or just not known in our technological age, yet as this story shows they could be useful some day.) – Courtesy *Flight Safety Focus*, January No. 1/80. ■

Inflight Weather Avoidance Service

continued from page 5

as possible in order to provide an advisory service.

Air Traffic Control's Responsibilities

USAF and U.S. civilian controllers are bound by procedures published in FAA Handbook 7110.65 (Air Traffic Control). This handbook specifically established guidance to controllers. involving weather. Paragraph 522 states:

"a. Issue pertinent information on observed/reported weather or chaff areas. Provide radar navigational guidance and/or approve deviations around weather or chaff area when requested by the pilot. Do not use the word 'turbulence' in describing radar derived weather.

"(1) Issue weather and chaff information by defining the areas of coverage in terms of azimuth (by referring to the 12 hour clock) and distance from the aircraft or by indicating the general width of the area and the area coverage in terms of fixes or distance and direction of fixes.

"(2) When a deviation cannot be approved as requested, and the situation permits, suggest an alternative course of action.

"b. In areas of significant weather, plan ahead and be prepared to suggest, upon pilot request, the use of alternative routes/altitudes.

"522.b NOTE – Weather significant to the safety of aircraft includes such conditions as tornados, lines of thunderstorms, embedded thunderstorms, large hail, wind shear, moderate to extreme turbulence (including CAT), and moderate to severe icing.

"c. Inform any tower for which you provide approach control services if you observe any weather echoes on radar which might affect their operations.

"Phraseology:

"WEATHER/CHAFF AREA BETWEEN (number) O'CLOCK AND (number) O'CLOCK (number) MILES. or

"(number) MILE BAND OF WEATHER/CHAFF FROM (Fix or number of miles and direction from fix) TO (fix or number of miles and direction from fix). or

"Level number and intensity adjective) WEATHER ECHO BETWEEN (number) O'CLOCK and (number) O'CLOCK (number) MILES, MOVING (direction) AT (numbers) KNOTS, TOPS (Altitude)."

"521.c. Example – 'Level 5 intense weather cell between eleven o'clock and one o'clock, one zero miles. Moving east at two zero knots, tops flight level three niner zero.

"521.c. NOTE – The third phraseology is only applicable when the radar weather echo intensity information is determined by NWS radar equipment."

This paragraph on weather is located in the "Additional Services" section of the ATC Handbook. It is considered to be an additional duty. Paragraph 510 states:

Application

"Provide additional services to the extent possible contingent only upon your capability to fit it into the performance of higher priority duties and on the basis of the following:

"510. Reference – Duty Priority, 22.

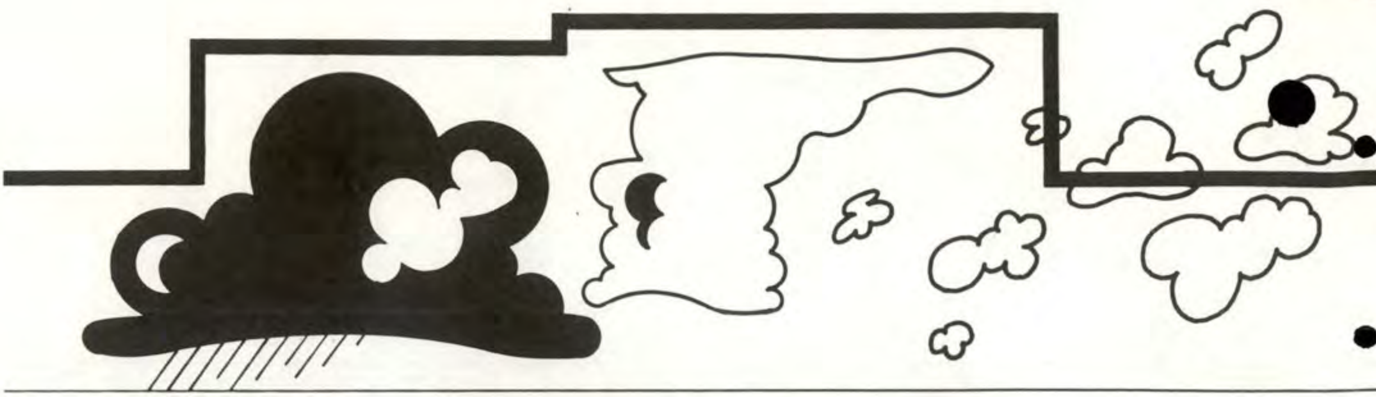
"510. NOTE – The primary purpose of the ATC system is to prevent a collision between aircraft operating in the system and to organize and expedite the flow of traffic. In addition to its primary function, the ATC system has the capability to provide (with certain limitations) additional services. The ability to provide additional services is limited by many factors such as the volume of traffic, frequency congestion, quality of radar, controller workload, higher priority duties and the pure physical inability to scan and detect those situations that fall in this category. It is recognized that these services cannot be provided in cases in which the provision of services is precluded by the above factors. Consistent with the aforementioned conditions, controllers shall provide additional service procedures to the extent permitted by higher priority duties and other circumstances. *The provision of additional service is not optional on the part of the controller, but rather is required, when the work situation permits.*

a. Factors such as limitations of the radar, volume of traffic, frequency congestion and volume of workload.

b. You have complete discretion for determining if you are able to provide or continue to provide a service in a particular case.

c. Your reason not to provide or continue to provide a service in a particular case is not subject to question by the pilot and need not be made known to him."

Additional services are third in controller's priorities behind the



separation of aircraft and other required services.

Information Available to Aircrews

USAF aircrews have limited information available to them in flying publications or regulations. AFR 60-16, Interim Change 78-01 to page 5-6, para 5-22, contains the following guidance:

"a. Thunderstorm penetration. Except for MAJCOM approved missions requiring planned penetration of thunderstorms, there is no peacetime mission which requires intentional thunderstorm penetration.

"b. Operations in the vicinity of thunderstorms. Apply the following procedures for operations in the vicinity of thunderstorms:

"(1) Do not take off, land, or fly approaches at an aerodrome if thunderstorms are producing hazardous conditions. Such hazardous conditions may include hail, strong winds, gust front, wind shear, heavy rain, or lightning (see AFM 51-12).

"(2) When observed or reported thunderstorm activity adversely affects the flight plan route, pilots will delay the scheduled mission, alter the route of flight to avoid the thunderstorm activity, or proceed to a suitable alternate. Aircrews will use all available facilities, to include radar, PMSV, and PIREPS, to avoid thunderstorm activity, AFM 51-12 contains a discussion of operations in and in the vicinity of thunderstorms.

"(3) MAJCOMS will supplement this paragraph as necessary to provide additional guidance. Such guidance will consider such factors as mission urgency, aircraft operating characteristics, aircrew experience, and climatological conditions."

The Airmen's Information Manual contains an indepth discussion that covers thunderstorms, radar, and ATC procedures. Part of that publication is:

ATC Inflight Weather-Avoidance Assistance

"To the extent possible, controllers will issue pertinent information on weather or chaff areas and assist pilots in avoiding such areas when requested.

"Pilots should respond to a weather advisory by either acknowledging the advisory or by acknowledging the advisory and requesting an alternate course of action as follows:

"a. Request to deviate off course by stating the number of miles and the direction of the requested deviation. In this case, when the requested deviation is approved the pilot is expected to provide his own navigation and to remain within the specified mileage of his original course.

"b. Request a new route to avoid affected area.

"c. Request a change of altitude.

"d. Request radar vectors around affected areas.

"For obvious reasons of safety, an IFR pilot must not deviate from the course or altitude/flight level without a proper ATC clearance. *When weather conditions encountered are so severe that an immediate deviation is determined to be necessary and time will not permit approval by ATC, the pilot's emergency authority may be exercised.*

"When the pilot requests clearance for a route deviation or for an ATC

radar vector, the controller must evaluate the air traffic picture in the affected area, and coordinate with other controllers (if ATC jurisdictional boundaries may be crossed) before replying to the request.

"It should be remembered that the controller's primary function is to provide safe separation between aircraft. Any additional service, such as weather avoidance assistance, can only be provided to the extent that it does not derogate the primary function. It's also worth noting that the separation workload is generally greater than normal when weather disrupts the usual flow of traffic. ATC radar limitations and frequency congestion may also be a factor in limiting the controller's capability to provide additional service.

"It is very important therefore, that the request for deviation or radar vector be forwarded to ATC as far in advance as possible. Delay in submitting it may delay or even preclude ATC approval or require that additional restrictions be placed on the clearance. Insofar as possible the following information should be furnished to ATC when requesting clearance to detour around weather activity:

a. Proposed point where detour will commence.

b. Proposed route and extent of detour (direction and distance).

c. Point where original route will be resumed.

d. Flight conditions (IFR or VFR).

e. Any further deviation that may become necessary as the flight progresses.

f. Advise if the aircraft is equipped with functioning airborne radar.

"To a large degree, the assistance that might be rendered by ATC will depend upon the weather information available to controllers. Due to the extremely transitory nature of severe weather situations, the controller's weather information may be of only limited value if based on weather observed on radar only. Frequent updates by pilots giving specific information as to the area affected, altitudes, intensity and nature of the severe weather can be of considerable value. Such reports are relayed by radio or phone to other pilots and controllers and also receive widespread teletypewriter dissemination.

"Obtaining IFR clearance or an ATC radar vector to circumnavigate severe weather can often be accommodated more readily in the enroute areas away from terminals because there is usually less congestion and, therefore, greater freedom of action. In terminal areas, the problem is more acute because of traffic density, ATC coordination requirements, complex departure and arrival routes, adjacent airports, etc. As a consequence, controllers are less likely to be able to accommodate all requests for weather detours in a terminal area or be in a position to volunteer such route to the pilot. Nevertheless, pilots should not hesitate to advise controllers of any observed severe weather and should specifically advise controllers if they desire circumnavigation of observed weather."

Summary

Aircrews and controllers must work together when flight is conducted near thunderstorms. ATC has a limited capability to assist aircrews by use of radar. However, certain inherent limitations need to be known by aircrews when working within the ATC system. ATC will attempt to vector aircraft around displayed weather cells upon pilot request. On occasions, controllers may unknowingly suggest a heading or route that would place an aircraft in a thunderstorm. A controller may be using special features on the radar to eliminate weather.

The first priority of Air Traffic Control is to provide separation between aircraft. Weather information need not be issued if other duties preclude providing this service. This is an additional duty; however, pilots should not hesitate to advise controllers of any observed weather and should specifically advise controllers if they desire circumnavigation of observed weather. Pilots often will see thunderstorms or portions not seen on radar. The best way to avoid other aircraft and thunderstorms still remains with the pilot—looking out the windscreen in order to see and avoid. ■

Gold In The Cockpit

There's nothing wrong with being a gourmet, unless one's proclivity for creative eating causes someone trouble. The following, submitted by a Danish Air Force Chief of Safety, tells of an incident which could have had serious consequences because of a gourmet's lack of good judgment.

■ Recently a Danish Draken pilot "struck gold"; unfortunately it happened in an aircraft during flight. The pilot flew an ACT mission which involved negative G manoeuvres. During one of these manoeuvres a 1-krone piece (coin) appeared in the pilot's view and he managed to catch it. After landing, the pilot found that his ballpen was missing, luckily enough one might add, because during the search in the aircraft for the ballpen a 5-krone piece was found. Now the men got greedy and decided to remove the ejection seat, and sure enough the fortune was revealed: another 5-krone piece and four 1-krone pieces, so we now had a total of fifteen kroner, not bad (about $3). Then the flight safety people heard about it, confiscated the money and initiated an investigation. We also found a piece of paper containing the name and address of a USAFE employee. A phone call revealed the whole story and confirmed the total sum of money to be exactly 15 kroner.

Some time ago the aircraft in question visited a USAFE base. The pilot was contacted by the employee, who wanted to buy some remoulade (Danish food dressing) and would leave the pilot his address the next day. Unfortunately, the pilot did not meet the man the next day and forgot all about the episode and returned to home base, not knowing that he actually carried 15 kroner, wrapped in a piece of paper, somewhere in the cockpit.

The aircraft flew 15 sorties before the money was found. Imagine what sort of damage five quarters and two Ike dollars could cause if lost in a cockpit.

The Danes are very proud of their food products, especially when foreigners show an interest in them, and we will be glad to meet any reasonable request in the future. In turn, we request the transaction to take place in "broad daylight" to eliminate surprises of this nature. —P. E. Hansen, Chief of Flight Safety, Airstation Karup, Denmark. ■

WHIFFERDILLS continued from page 7

motions (most easily seen with stab aug or CAS off, these are the "Dutch roll" and the "short period" modes of motion), reinforcing them until a divergence or catastrophic failure occurs. This reinforcing effect may be best understood as a resonance between inertial and aerodynamic forces, leading to ever-increasing yaw and pitch excursions from the flight path.

Some Solutions

Now that the reasons for roll coupling are clear, how can it be avoided? Generally, changes of mass distribution are impractical, but rate dampers in the pitch and yaw axes can reduce coupling into the Dutch roll and short period modes of motion by damping the motions themselves, thereby raising the critical roll rate for divergence. Other preventive measures also are normally required, such as limiting roll travel to less than 350 degrees. This restriction limits the time duration that the destabilizing forces can reinforce the yawing and pitching modes of motion and thereby keeps sideslip and angle of attack within acceptable limits.

Other preventive measures involve placing restrictions against full deflection rolls at less than one, or less than zero g's, in order to limit angle-of-incidence problems. Lateral stick stop devices have also been used to lower maximum roll rates in some fighters. Similarly, CAS and fly-by-wire control systems, employ lowered aileron gains and deflections, or use electronic roll rate limiters in order to keep roll rates less than critical for 360-degree rolls. Such limiters are normally dependent upon flight conditions to avoid poor transient lateral response in low speed flight conditions.

In summary, today's high performance fighter airplanes are typified by high fuselage densities and little rolling inertia in order to attain the high speeds and good rolling performance required. Accordingly, they suffer from a cross-coupling resonant condition when gyroscopic and inertial forces associated with high roll rates overpower normal aerodynamic stabilizing forces, leading to divergence and departure from controlled flight. Unlike loss-of-control departures at high angles of attack, these cross-coupling departures occur primarily at high speeds and low angles of attack where roll rates are highest. Unfortunately, if this type of departure does occur, the results are usually catastrophic due to extremely high airloads. Even though rolling limitations may sometimes seem unnecessary, they do have a very firm grounding based on some very real problems. Suitable respect for these limitations can go far towards making high performance flight safer and more enjoyable. So the next time you hear someone grumble about "unnecessary rolling restrictions," point out these dangers and explain why the restrictions exist. After all, you're an expert now! —Courtesy *Product Support Digest,* McDonnell Aircraft Company. ■

WHAT, ME WORRY?

CAPTAIN GORDON N. GOLDEN
Directorate of Aerospace Safety

■ What a beautiful day to go slip the surlies. Too bad it's a two-holer, but at least I'm in the front today. "You ready to start? Let's get this show on the road." Sounds like a good start . . . gages all look good . . . power cart disconnected . . . run'er up for the checks . . . what was that? "What the . . .?"

Ground egress (ground ē'gres) n. Something you have to do with a life support troop every six months to fill a square on his training board. Right? Wrong! It may save your life.

Why all the hassle? Anybody can get out of his aerospace machine while it's sitting on the ground, no sweat. Wrong again. Maybe we should take a look-see at the record and see what we can find. Yeah, I thought so, here's just a couple from last year.

A fighter jock on a cross-country refueling stop was starting his machine when an aircraft air bottle exploded and ruptured a fuel tank; the plane was engulfed in flames. In his attempt to exit the area posthaste, the aviator got his egress a little out of sequence and didn't separate from the survival kit. So, he sat down and decided to initiate his alternate course of action to separate himself from his encumbrances. Everything was hunky-dory as he leaped over the canopy rail except that he forgot the oxygen hose, which tied him to the aircraft. He died because he couldn't execute his ground egress when it counted.

Another fighter driver and his trusty WSO were in the process of rumbling down the runway on take-off when they had a hardover on the nosewheel steering which rapidly transformed their air machine into a flaming sled as it left the runway. What transpired over the interphone we'll never know, but it must not have been very enlightening because the front seater unstrapped for a ground egress and the back seater initiated a sequenced ejection. The front seater died as a result of his no-chute ejection. The rear seat rocket didn't fire, and the WSO died when he hit the runway still in the seat. Had they discussed what they would do in a ground emergency? Do you?

The whole airplane's on fire! Gotta get outa here . . . where's that kit release? . . . straps . . . over the side. Sure is hard to run with that survival kit draggin' along . . . wish I had my nomex jacket. . . .

Your ability to set an emergency ground egress speed record and do it right could be the difference between life and death. It has been for others. ■

CAPTAIN
Stephen J. Feaster

FIRST LIEUTENANT
Roy A. Gilbert

27th Tactical Fighter Wing
Cannon Air Force Base, New Mexico

■ On 20 September 1979 Captain Feaster and Lieutenant Gilbert were flying a night range mission in an F-111D. During base turn for weapon delivery, while performing automatic terrain following flight at 1,000 feet AGL, both crewmembers heard a thump and observed a flash of light from the left side of the aircraft. They checked the engine instruments, noting nothing unusual. At the same time, Captain Feaster disengaged the automatic terrain following system, rolled wings level and began a climb. He checked engine response to throttle movement and ascertained that both engines appeared to be operating normally – the only discrepancy was the left nozzle slightly open. The crew again heard a thump and saw a flash of light followed by left engine rollback, which was confirmed on engine instruments. As Captain Feaster retarded the left throttle, the left engine fire warning light illuminated. He continued retarding the throttle to the cutoff position and Lieutenant Gilbert depressed the fire pushbutton and activated the fire agent discharge. The Range Control Officer (RCO) was notified of the situation and confirmed that he had seen indications of a fire. The crew then contacted the Supervisor of Flying (SOF), notifying him of their intention to land as soon as possible. During this time the fire light went out. Captain Feaster checked the warning circuit, found it to be inoperative, and notified the SOF he might still be on fire. The tower turned the runway lights for the nearest runway to bright and Captain Feaster visually acquired the runway, positioning himself to intercept final approach approximately seven miles from touchdown. While positioning the aircraft, the crew configured for a single engine landing and computed heavyweight final approach speed. Having no instrument glide path aids available, Captain Feaster requested the VASI lights be turned on. While on final approach, the SOF advised the crew that they appeared to be on fire and should take the approach end barrier. Captain Feaster and Lieutenant Gilbert completed a final review of required checklist items and reconfirmed proper configuration prior to executing a flawless approach end barrier engagement. As the aircraft came to a stop, leaking fuel from a ruptured fuel tank engulfed the aft section of the aircraft in flames and the crew successfully ground egressed. The prompt reactions and superior airmanship displayed by Captain Feaster and Lieutenant Gilbert, with aggressive support by the base fire department, not only averted injury or loss of life, but held aircraft damage to a minimum. WELL DONE! ■

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UNITED STATES AIR FORCE

Well Done Award

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

FIRST LIEUTENANT
James R. Mitchell
81st Tactical Fighter Wing

■ On 14 August 1979, Lieutenant Mitchell was flying an A-10A on a range mission in The Netherlands. The range work was uneventful, but while returning to England at FL 200 over the North Sea, he noted that the control stick would not move aft of the neutral position. The aircraft began a shallow dive which could not be controlled by back-pressure. Lieutenant Mitchell informed his flight lead of the problem, and lead suggested unloading the aircraft and snapping the stick aft to free the jam. This maneuver freed the stick and he leveled off at FL 170. Lieutenant Mitchell declared an emergency and began a slow descent into RAF Bentwaters. When he attempted to level off at FL 120, the stick again would not come aft of the neutral position. He again unloaded the aircraft and snapped the stick aft, freeing the jam. Another slow descent was initiated, and the stick jammed for a third time. Lieutenant Mitchell unloaded and attempted to snap the stick free as before. Rather than freeing the jammed condition, the aircraft controls remained jammed, and the aircraft entered a 25 to 30° nose down attitude. The aircraft rapidly lost altitude, and he tried to free the stick by unloading and applying as much back-pressure as possible. He informed lead that he would eject if he could not free the stick by 2,000 feet AGL and, as a last effort, braced his foot against the instrument panel while continuing to pull as hard as possible. This effort freed the stick and he leveled off at 1,000 feet AGL. After performing a controllability check, he attempted to land. At landing airspeed, after the gear was lowered, the stick jammed with the aircraft in a slightly nose high attiude. Lieutenant Mitchell raised the gear and freed the jam by using firm back-pressure on the stick. After another controllability check, with satisfactory results, Lieutenant Mitchell left the aircraft configured with gear down, flaps up, and speedbrakes closed, and executed a flawless landing with a minimum flare in a high cross wind. Investigation revealed that a pencil had lodged in the bob weights of the flight controls. Lieutenant Mitchell's calm and timely actions resulted in the safe recovery of the aircraft. WELL DONE! ■


Make Sure Of Your CLEARANCE...
Before You Get On The RUNWAY!