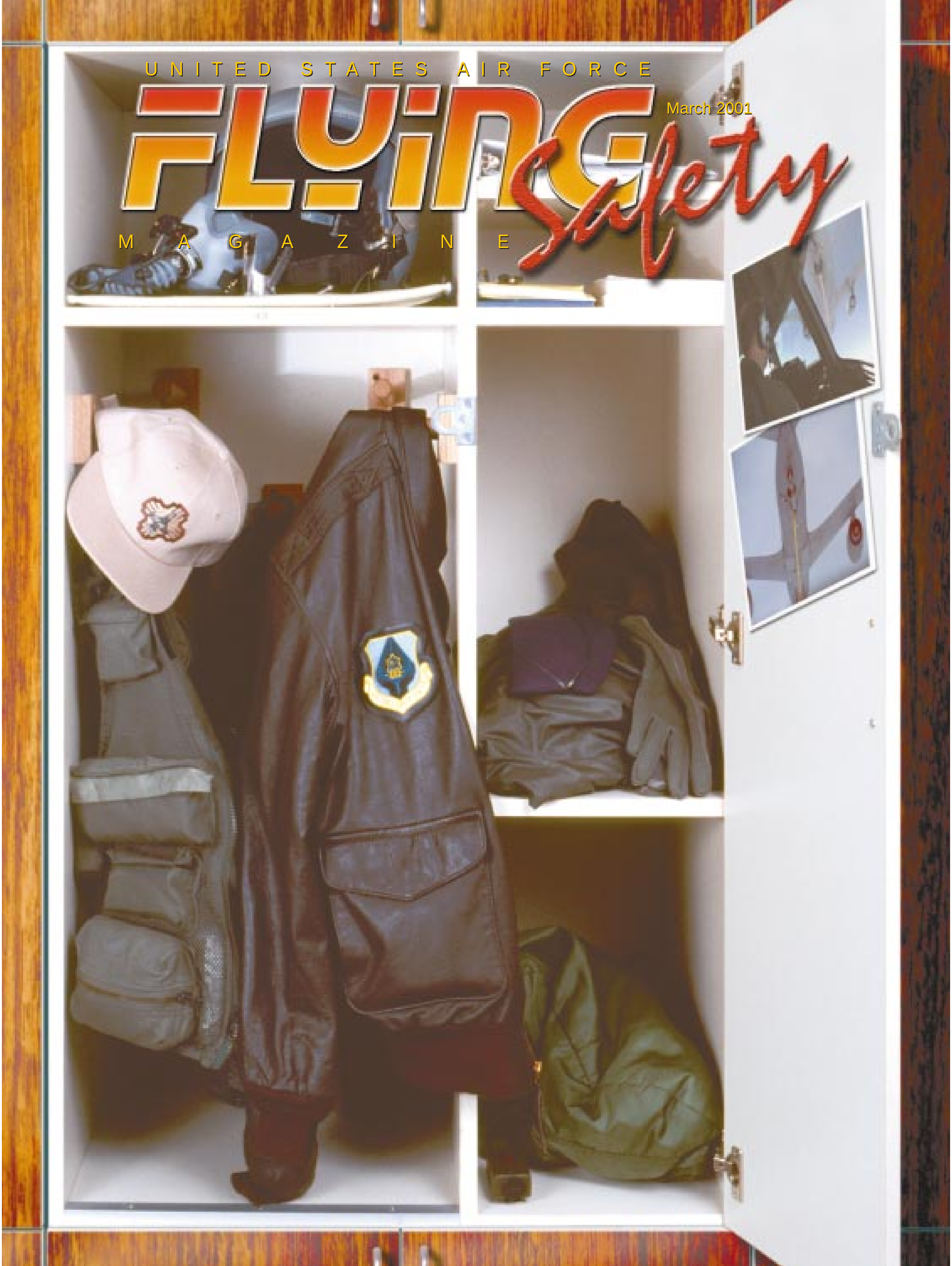

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4

12

24

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FSM notams

A WINTER'S TALE

Courtesy ASRS *Callback* #248, Feb 00
NASA's Aviation Safety Reporting System

An air carrier Captain described a hazardous dawn takeoff in snowy weather at an uncontrolled field.

We called ATC for clearance... We were given 5 minutes to be airborne. As we approached the runway First Officer called CTAF 122.8 and announced takeoff position. I noticed that I could see the terminal and...lights beyond the airport. It was dawn and it was gray with little contrast in light snow. I was off UNICOM frequency. As I saw 100 knots the First Officer said, "There's a snow plow on the runway!" It took several seconds to acquire any image that looked like an object. It was a dim gray spot on the right side of the runway far away. No lights were visible. It was within 100 feet of the end and on the right edge of the runway. Not until we were close could we see lights on it. We passed well above it. Neither of us saw any obstacle on the runway from takeoff position. It was virtually obscured by the snow billowing around and over it as it headed into a 20-knot wind.

Had we not been pressed for time, we more likely would have made the CTAF "starting to taxi out" call which would have alerted the plow crew sooner... When any plow is on the runway, the plow crew should place a handheld rotating beacon on the runway at the edge near the takeoff end. This could be Standard Operating Procedures at all uncontrolled airports where snowplows operate...

Errata

A couple of errors in the Annual Mishap Issue (January/February 2001) have been brought to our attention.

The chart on pages 14-15 cited 44 Class A mishaps for the F-16 during the years 1975-83; the actual number was 42.

Further, the column heading "Average Class A Rate per 100,000 Flying Hours" was misleading. This should have read "Average of Annual Class A Rates." The intent was to show how Class A mishaps toward the beginning of the an airframe's lifespan yield a higher average, but the heading gave the impression these were the straight Class A rates for those years, rather than an *average* of rates.

A typographical error in the F-16 chart on page 26 gave the Destroyed Aircraft Rate for FY91 as 1.09. The actual rate was 4.55.

"A New Age in Deicing" listed incorrect web addresses on page 32. The correct addresses are:
https://afpet.lackland.af.mil/sft/techorders/tos/42C-1-2.pdf
http://www.andrews.af.mil/tenants/affsa/AFFSAXO.htm

Our previous issue gave an incorrect address for the Safety Center Web page. The correct address is: http://safety.kirtland.af.mil/

To view statistics as mentioned in the Class A Flight Mishaps page, the new address is:
http://safety.kirtland.af.mil/AFSC/statspage.html

Oh, The Regs They are a Changin'

CAPT MIKE WOOD
60 AMW
TRAVIS AFB CA

We can no longer be assured of the fact that the extended airspace is "sterilized" until the rendezvous is complete.

SAC Remnants

When I first came to the KC-10, we had a lot of guys in the squadron who had flown the airplane when it was in SAC (OK guys, you can stop all the flag waving and music). One of the better things they brought with them from those days (besides a couple of good alert stories) was SACR 55-3, *Airspace Management*, which consolidated a lot of information from various sources into a single place. Unfortunately, SACR 55-3 never survived the transition ("degeneration" for all of you hard-core SAC guys) from SAC to AMC, and the crews had to go back to keeping track of lots of hard-to-locate source regulations.

One of those regs was FAAO 7610.4, *Special Military Operations*. Among the more important sections of this regulation are the ones dealing with air refueling operations, formation operations and ALTRVs. Let's take a moment and review some of the highlights of the air refueling section.

Changes

All the "old heads" who grew up with SACR 55-3 or the version of 7610.4 that it was drawn from (7610.4H, dated 1990) will find a few surprises in the latest release of 7610.4 (7610.4J, dated 1998). From a tanker pilot's perspective, not all of the changes are good ones. Let's briefly recap some of the more significant changes and consider their implications on USAF air refueling operations:

1. In the past, a "clearance to conduct air refueling" authorized the tanker to extend the tanker orbit pattern all the way down to the ARIP, if necessary, to effect the rendezvous. In the latest version of 7610.4, this verbiage has disappeared, which puts the burden on the aircrew to ensure they have this airspace extension to work with. Without verbal confirmation, you must assume you are limited to the 25-by-60-mile tanker orbit pattern box. In addition, we can no longer be assured of the fact that the extended airspace is "sterilized" until the rendezvous is complete. Instead, ATC will use standard separation procedures to keep other aircraft clear of you during the rendezvous, but that's about it.

2. The old 7610.4 defined ATC-protected airspace as 10 miles either side of track along the length of the entire track above Flight Level 180. The old 7610.4 also directed you to "remain within [this] protected...airspace." However, protected airspace is no longer defined in 7610.4. In fact, the 7610.4 specifically requires you to maintain track centerline unless otherwise cleared.

3. The old 7610.4 described protected airspace which existed on the overflown side of a track when the track had a turn built into it, but the new 7610.4 doesn't address it. There is surely some protection that must be built into such a turn, but we don't know what it is anymore.

4. The old 7610.4 described protected airspace surrounding an anchor (28 miles wide by 84 miles long for a typical 20 x 50 anchor) but the new 7610.4 doesn't. Is there still protected airspace around an anchor? Probably, but we don't know what the dimensions are anymore.

5. The old 7610.4 directed you, as a tanker, to keep receiver aircraft within three miles of the tanker after rendezvous completion until MARSA was terminated by ATC. The new version simply requires you to keep the receiver "in either standard or non-standard formation until further ATC clearances are

received." Note that the receiver is still required to squawk NORM if distance exceeds three miles from the tanker.

6. The old 7610.4 required a 10-minute entry interval between multiple cells conducting an en route rendezvous at the same point and altitude. The new 7610.4 has increased that to 20 minutes and now specifies that tankers and receivers must be within +/- five minutes of the rendezvous time.

7. The new 7610.4 describes procedures for when the tanker arrives at the ARCP and doesn't receive a clearance from ATC. If you don't receive clearance from ATC, then go down track and fly the flight-planned route—do *not* conduct air refueling until ATC clearance is received.

8. The new 7610.4 specifically authorizes you to file directly to the anchor point without going through an entry point when flying as a tanker.

9. The new 7610.4 requires you to "fly the black line" in an anchor unless otherwise approved/cleared by ATC. This means that if your receiver wants to stay on one end of the anchor, if you want to do figure-8s, or if you want to shorten an anchor for timing, then you'll need a specific ATC clearance to deviate from the racetrack pattern.

10. The new 7610.4 provides guidance on tanker and receiver actions in the event they arrive at the end of track/anchor with no further clearance. Tanker and receiver will either continue on tanker's filed route and assigned block altitudes until clearance to separate the flight can be obtained, *or* request an extension of the air refueling track. (NOTE: Terminate AR at the end of track until the extension request is approved.)

11. The new 7610.4 mandates a 40-minute minimum entry interval between a point-parallel rendezvous and an en route rendezvous on the same track, regardless of which is scheduled first.

12. The new 7610.4 increases the required separation between anchor points from 60 miles to 80 miles for simultaneous refuelings in multiple, adjacent anchors.

13. The new 7610.4 specifies that 2,000 feet vertical separation between altitude blocks is required for multiple air refuelings within one anchor (previously, this was only specified for tracks).

14. The new 7610.4 requires the tanker to coordinate new AR track times with the track scheduling agency if unable to meet scheduled ARCTs and minimum entry intervals.

15. The new 7610.4 requires receivers to initiate the request for an altitude change in sufficient time to reach the required air refueling block altitude prior to the ARIP.

16. The new 7610.4 requires receivers to maintain two-way radio contact with ATC until released by ATC to the tanker (previously, receiver had to maintain contact with ATC until cleared to the air refueling block altitude and established in that block).

17. The new 7610.4 requires ATC to obtain MARSA before the receiver can be switched to the tanker C/R frequency.

Why All The Changes?

It will surprise nobody that the dramatic increase in global air traffic has placed a greater strain on ATC and a higher premium on available airspace. The logical extension of these concepts is to place greater restrictions on the airspace available for air refueling operations and to implement procedures that provide for greater levels of control and aircraft separation without adding to ATC's already-high workload. These concepts have translated into many of the changes previously identified.

Uncle!

Right about now, many of you are probably shocked to see how many changes have occurred in 7610.4 since the last time you reviewed it. How many of you were even aware of the release of 7610.4J in 1998? This new version includes many more changes that are worthy of your attention, so it would be well worth your time to take a look at it and see what else you're missing! It's available for your viewing pleasure on the web at www.faa.gov/atpubs.

We may not be issued FAAO 7610.4, but that doesn't mean we can remain unaware of its provisions. If we want to continue our long-standing tradition of safe, professional aerial refueling operations, then we need to keep FAAO 7610.4 in our crosscheck.

Fly Safe!

Capt Mike Wood is the Chief of KC-10 Training for the 60th Air Mobility Wing at Travis AFB, CA. He is a Senior Pilot who has flown the KC-10 since 1995.

EDITOR'S NOTE: HQ AMC/DOV message date time group 152039Z Nov 00 issued FCIF 00-11-14 and AETC FCIF 00-1102 informing tanker aircrews of FAAO 7610.4J changes and also refers tanker aircrews to the FAA website.

The logical extension of these concepts is to place greater restrictions on the airspace available for air refueling operations.

NATO Air-To-Air Refueling

WING COMMANDER FRED HARBOTTLE
ROYAL AIR FORCE
MAJOR PETER SMIDT
ROYAL NETHERLANDS AIR FORCE
TRAVIS AFB CA

A Scenario on Operations in the Adriatic

After a long and uneventful mission flying on a refueling track in the Adriatic, DRUM 43 (KC-135) receives a message from Magic 24 (AWACS): "DRUM 43, what is your maximum transferable fuel?"

After a short pause, DRUM 43 responds, "22,000 pounds."

Magic 24 replies, "DRUM 43, message from CAOC, you are to remain on your present track and pass your remaining fuel to MATADOR formation. Expect them at 2145 hours."

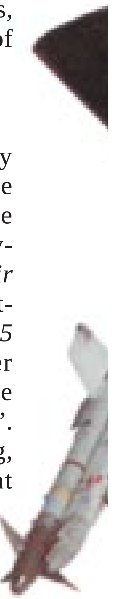
There is much discussion among the crew, and a check of the Air Tasking Order (ATO) reveals that MATADOR formation should be four Spanish F-18s. The crew is also aware the operation is being conducted in "EMCON 2" conditions, but they realize the receivers are unlikely to have secure communications. They wait. Five minutes later, the boom comments he can see a formation of four fighters joining in echelon on the right of their aircraft. The copilot watches them move forward into his view. They wait.

The crew returns to base with tales of some "crazy Spanish Matadors."

The wing hoses are trailed and DRUM 43 is ready to pass fuel. There is no movement. The F-18s stay on the right wing. After what seems an age, the first aircraft moves astern, closely followed by the second. Three and four disappear, descending rapidly heading west. MATADOR 1 moves into the pre-contact position and then rapidly into contact; fuel begins to flow.

Meanwhile, 2 moves forward erratically. As the end of the towline is approaching, the aircraft commander initiates a turn. Suddenly, MATADOR 2 transmits "Spokes." MATADOR 1 then moves back quickly and disconnects, descending 200 feet and dropping back to half a mile. The boom reports that 2 is also dropping back and then rapidly down calling, "MAYDAY, MAYDAY, MAYDAY; MATADOR 2, engine failure, requesting immediate descent and recovery to nearest suitable diversion."

This is the last DRUM 43 sees of the F-18s, and the crew returns to base with tales of some 'crazy Spanish MATADORs.'



So What Went Wrong?

Firstly, was the tanker crew adequately prepared to refuel the Spanish fighters? The refueling hoses were trailed, but what more could the crew have done? They were carrying ATP 56(A), *The NATO Air-to-Air Refueling Document*—a requirement as stated in AFI 11-2KC-135V3, *C/KC-135 Operations Procedures*—but had they ever looked at it? If they had, they would have known the implications of "EMCON 2". When the F-18s arrived on the right wing, the tanker crew should have realized that MATADOR 1 was waiting for the upper anti-collision light to extinguish, indicating he was clear astern.

The five minutes waiting made 3 and 4 too short of fuel to wait, so they turned for home. When 2 was approaching the basket, the aircraft commander should have held his turn until the receiver had made contact, or put the red signal light on until he was established in turn (contacts / disconnects are not to be permitted during tanker attitude changes). When 2 called "Spokes," the boom or aircraft commander should have told him to maintain his position (in clear) and should then have instructed 1 to disconnect before instructing 2 to withdraw "down the line of the hose." MATADOR 2 should have then been warned about the possibility of FOD ingestion and advised to return to base.

Why ATP 56?

ATP 56(A) was born out of a growing realization that European operations were likely to involve all of NATO's tankers, and having compatibility and interoperability would be a massive bonus. Since then a vast amount of work has been done to ensure all NATO nations are in agreement with the procedures outlined in the ATP. Every six months an Air Refueling Systems Advisory Group (ARSAG) Conference is held which brings together all NATO members, as well as the manufacturers of the refueling equipment. If required, amendments are made following the Conference and posted on the website at http://www.raf.mod.uk/publications/aar/index.html. All NATO nations are signatories to ATP 56(A), with the only exceptions to procedure being the Greeks, with restrictions to refueling over their mainland in times of peace and war.

learning from the 47 years of probe and drogue jet refueling experience gained by our European partners?

The USAF conducts around 90% of the AR taking place in the world at any time, and there is no question that boom refueling is very professionally practiced. However, ask any USAF tanker crew to describe what they would have done in the scenario above and very few would have deferred to ATP 56(A) procedures.

USAF Photo by SrA Greg L. Davis

ATP 56(A)—That's a British Manual, Isn't It?

So, if we have been signatories to this ATP for the past decade, why is it that 90% of USAF tanker crews have never heard of ATP 56(A), let alone used it? Simply put, it is because most of our refueling has been on the boom and within CONUS, or with other USAF aircraft. All of the regulations pertaining to this are covered in T.O. 1-1C-1-3. On operations in the Bosnian theater, the Europeans often refuel US Marine Corps and US Navy jets, and the European receivers mainly use their own tankers unless they are receptacle-equipped. (During the Kosovo operation, both British and Dutch tankers gave away over 80% of their fuel to other air forces.) However, more and more of our tankers are getting wing air refueling pods. Eventually, 15 KC-10s will be equipped with Wing Air Refueling Pods (WARPs) and 45 KC-135s will gain Multi-Point Refueling Systems (MPRS). So, since the first British jet tanker was a Canberra, which first flew in 1953, should we not be

So Why Do We Need Different Procedures for Probe and Drogue Refueling?

ATP 56(A) orders that we all join our tanker in a loose echelon right position. Why? Simply because when hoses are trailed out and wound in, they can come off the drum and could hit a receiver joining astern. (In 1983, a Vulcan B2(K) captain of 50 Sqn [RAF] sent a receiver astern, only to discover their hose was missing and had presumably been

continued on next page

In addition, no contacts should be made while rolling into and out of turns because probe tips could be removed and baskets damaged.

deposited in the North Sea.) Additionally, receivers can join much quicker if they join in echelon, as less judgment is needed because a slight overtake on the right is not going to excite a tanker crew as much as an overtake going down and forwards under the tanker. Receivers then expect to be ordered around the tanker by the formation leader who becomes the tanker aircraft commander as soon as they join. The reasoning behind this is that he is in the best position to know when the aircraft is going to turn, who is joining next and who is leaving the formation. He is also monitoring the radios and responds to the directions of the controlling authority.

Furthermore, although ATP 56(A) describes all of the formation moves required by the receivers, these are directed by the tanker aircraft commander as he deems necessary. For example, simultaneous movement by both receivers forward into contact is not to be practiced. Hard-earned experience has shown us that typically receivers only have a requirement to receive fuel once every six months and are not generally skilled enough to move forward into the contact position without plenty of lateral movement. Couple that with the fact that some receivers have probes on the right and some on the left. Get the wrong two together on the 'wrong sides' and they will get very close. For example, the Tornado F3 and GR4, although similar types, have probes on opposite sides of the aircraft.

It is also normal for a tanker aircraft commander to call turns at night with receivers on the wing pods because, as the tanker rolls into the turn, the baskets travel 40 feet vertically. In addition, no contacts should be made while rolling into and out of turns because probe tips could be removed and baskets damaged. There are additional restrictions at night and during conversion exercises which have also been placed on receivers due to many incidents over the years.

The question is, how many USAF tanker crews are aware of these restrictions when operating with WARPs? Although the loss of a refueling probe or basket can be considered a training risk, debris from the basket is often ingested into a receiver's engine and the results can be catastrophic. Furthermore, the cost of a basket is around $100,000!

Future Aspirations?

So, where do we go from here? There are those who believe that all of NATO should be using one refueling manual which details standard procedures, with each country having a national annex describing features unique to that country. The UK Air-to-Air Refueling National Instructions (AARNIs) contain details of UK air refueling areas, MDS-specific receiver techniques and planning factors for deployments. Any foreign crew conducting AR in UK airspace would be well advised to use ATP 56(A) procedures and to read the information in UK AARNIs. There would then be few surprises like the one described above.

However, what chance is there for the USAF to convert to these procedures? At the moment, the best we can hope for is that all tanker crews become conversant with the contents of ATP 56(A) and then start to carefully consider its use within their own environment. We could then see meaningful amendments being suggested which may make the document more palatable for USAF users.

As exchange officers operating with the USAF, we believe there is little which needs to be changed. However, the boom operators who see C-5-sized aircraft filling their boom windows daily, and who have experienced aircraft as slow as helicopters and as fast as SR-71s, need to be the ones to stamp their authority on the usability of this ATP. They then need to embrace and enhance the regulations contained within it so that all NATO members can feel comfortable with (truly) common NATO refueling procedures. If we fail to take this on board, we fear there will be many more baskets replaced and probes removed as the USAF learns its lessons the hard way.

Wing Commander Fred Harbottle is a Royal Air Force exchange officer currently assigned to 15th Air Force at Travis AFB, California. Formerly a Vulcan bomber pilot, his squadron underwent conversion to the air refueling role at the time of the Falklands Conflict. Since then he has flown many hours in Victor K2 and TriStar tankers. His operational experience includes operational missions in the Gulf War, Northern and Southern Watch and in the Adriatic AOR.

Major Peter Smidt is a Royal Netherlands Air Force exchange pilot assigned to the 9 ARS at Travis AFB, California. Having flown fighters for 27 years, he moved to the tanker world in 1997. From Eindhoven AFB in the Netherlands, he flew many missions in the KDC-10 during the Kosovo War.

MIXED CELL TANKER OPS


USAF Photo by A1C Gina Prescot

CAPT PHIL TUCKER
9 ARS
TRAVIS AFB CA

"Petro 61 flight, cleared for takeoff." When ATC issues those words, it's time to get the formation moving and find out if the extensive planning that went into devising a plan to join eight tankers (KC-10s and KC-135s) to refuel nine C-17s over the eastern Atlantic works. It may not appear complicated as you sit sipping your latte, but to accomplish such a mission safely and have it go off without a hitch is *not* an easy task.

While formation flight is relatively common for the KC-10 and KC-135, it *is* uncommon to conduct mixed cell operations. However, when the mission dictates and receivers need gas, the tanker guys do what is necessary to move the mission. To accomplish a successful formation flight, which could conceivably involve eight or more aircraft, thorough mission planning is required. That's where this article comes into play.

There are some good tidbits of information in the following pages for techniques that have proven to be successful in large cell / mixed cell operations. Their discussion may make you think about a facet of cell operations you hadn't previously considered. It goes without saying, the formation leader must devote considerable time in the planning stages of a sortie involving a large, mixed formation. The potential for numerous unplanned changes is high and this planning can identify and mitigate most of them before you're at 450 TAS and FL260. For the discussion, we'll assume all aircraft are departing from the same location. So here goes…

We all know how to fly our aircraft well, but joining two types of heavy aircraft in the same formation poses some interesting obstacles. Prior to starting engines and commencing the taxi, confusion can begin with the first radio check-in. When changing frequency, it's imperative for all cell members to acknowledge the radio call and not change frequency until all formation members have acknowledged the frequency change. There is always an intra-cell frequency (interplane), to be used within the formation that isn't used to communicate with ATC. A great technique is to select a formation call sign, which is different from the filed call sign, and initiate all calls on interplane with this call sign. For example, though you filed a call sign of Petro 61, you might select "Gray flight" as your intra-formation call sign. When initiating the call on interplane with "Gray flight…", all cell members know the call is on the *interplane* frequency and not from ATC. This can greatly reduce radio confusion. If the first check-in poses problems, it's bound to be a long day. Once over the radio discipline obstacle (and we're not actually over it until shutting down after a successful mission), engine start and taxi commence. Barring any maintenance delays during the start, and assuming a solid taxi plan has been for-

continued on next page

Prior to starting engines and commencing the taxi, confusion can begin with the first radio check-in.


USAF Photo by SrA Stan Parker

By having heavy aircraft depart first, subsequent aircraft aren't exposed to the wake turbulence produced by the preceding heavier jet.

mulated to ensure #6 doesn't end up in the #2 position, the time from chocks to the hold line is uneventful.

When given takeoff clearance, request ATC approval to change to the departure frequency. By accomplishing this on the ground, lead can avoid making the radio check-in with departure control while a cellmate is on the takeoff roll. Next comes the power push. The takeoff interval for tanker aircraft varies by aircraft type. The KC-135 has a 30-second minimum interval, while the KC-10 uses 60 seconds regardless of the type of preceding aircraft. This difference needs to be addressed in the cell briefing and all formation members should use a standard interval. To eliminate uncertainty, regulatory guidance states a 60-second interval will be used when departing behind a KC-10 for all tanker aircraft.

When planning the departure, aircraft gross weight should be considered in determining which aircraft depart first in a formation. By having heavy aircraft depart first, subsequent aircraft aren't exposed to the wake turbulence produced by the preceding heavier jet (they'll rotate before the heavier aircraft and fly above its flight path). Furthermore, since the heavier aircraft will have higher Vmm (minimum maneuvering) speeds, having them in the front of the formation will eliminate the hazard of a heavier aircraft (flying at its Vmm) eating up a lighter aircraft (flying at its Vmm). Such a scenario may require the heavy jet to climb with slats extended, which is forbidden in Air Force guidance. To illustrate this point, consider a KC-10, with a maximum takeoff weight of 590,000, and a KC-135R, tipping the scales at 322,500. The KC-10's maneuvering airspeed at this weight is 291 knots compared to approximately 205 for the -135. In such a situation, the KC-10 would be forced to fly at a minimum of 291 kts and would rapidly close on a -135 flying 205.

It would be worth considering having the KC-10 depart as lead to avoid potential climb / speed irregularities. To eliminate this problem, Air Force guidance calls for the lead aircraft of a formation to climb at 285 KIAS with formations consisting of KC-10s weighing less than 500,000 and 310 KIAS for formations with KC-10s over 500,000. However, the formation lead may adjust speeds as necessary but must ensure the profile is flown in excess of the heaviest aircraft's Vmm speed. It goes without saying a slower airspeed will more rapidly facilitate the formation rejoin, but with high gross weights, "slow" isn't always possible. In a situation requiring aircraft to fly fast Vmm's, subsequent formation members may not have much overtake capability due to aircraft limiting airspeeds. If an eight-ship departs, with the leader flying 285 kts, the 2-8 aircraft will each be limited to a maximum of approximately 10 kts of closure speed, and a straight ahead rejoin could take an eternity. Planning a departure routing with turns will allow wingmen to use lead and lag pursuit to close on lead and expeditiously join the formation; however, turns must be used carefully. Using a standard takeoff interval of 60 seconds, in an eight-ship cell, the #8 aircraft is eight minutes and, as the crow flies, about 32 miles behind lead. Therefore, if lead requests a radar vector departure to intercept an arc or, with ATC approval, begins turns to facilitate the rejoin, the formation can be more rapidly joined, but the potential exists for aircraft within the formation to have conflicting altitudes or flight paths due to degraded station keeping and poor formation positional awareness.

Finally, the departure profiles of the KC-10 and KC-135 are significantly different. The KC-10 uses a "pressure height for acceleration" on climbout. On all takeoffs, from liftoff to approximately 1500 feet AGL, the aircraft climbs in the takeoff configuration (with gear retracted) at V2+10 knots, at which time the climb rate is reduced to 500-2000 VSI (as determined by weight and desired climb profile). This change in vertical speed allows for acceleration to retract the flaps and slats and attain the desired climb speed of Vmm or 250 knots, whichever is greater. When compared to the KC-135's two climb profiles, it's easy to see some contrasts. The KC-135 has an acceleration climb profile that is designed for takeoffs with distant obstacles or with no obstacle at all. On such a departure, selecting accel climb on the flight director directs a pitch attitude that will allow the aircraft to retract flaps and leading edge flaps while accelerating in the climb. This profile is quite different from the KC-10's pressure height scenario. However, the KC-135's second flight director mode for takeoff, max climb, almost mirrors the KC-10's climb profile. Flying this method, the aircraft is climbed at a constant airspeed to 2000 feet AGL or obstacle clearance altitude, whichever is higher, and then pitch is adjusted to allow for acceleration and clean-up.

It's very important to consider these differences when planning a mixed cell departure. Ensure all cell members fly a profile within the limitations of their aircraft and compatible with the formation's parameters. While flying the formation, not only are you concerned with keeping your jet where it needs to be, it's imperative to remain situationally aware of the position of your cell mates. That's where the communication plan comes into play.

Obviously, the cell leader must create a communication plan that's compatible with the most restrictive formation member, but it can be difficult to juggle ATC, interplane and air refueling frequencies. Knowing the capabilities of all aircraft within the formation is key. For voice communication and station keeping, smart planning will make for a better-run formation and reduce confusion.

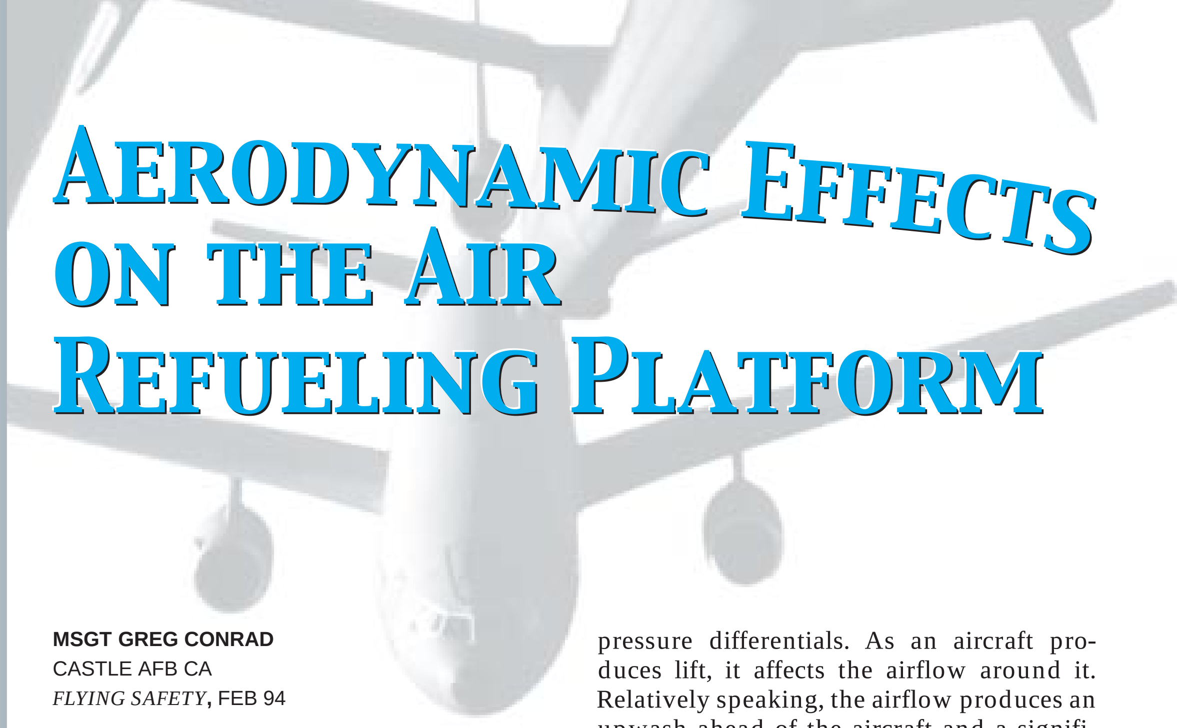
	TACAN	VOR	ADF	UHF	VHF	HF	BEACON
KC-10	2	2	2	2	2	2	I-BAND
KC-135	1	2	1	2	1	1	I-BAND

Developing a plan that will enable formation members to maintain situational awareness is vital. Not only will air-to-air TACAN be useful, but beacon transponder codes will also aid in station-keeping. Shacking the radar's tilt will allow you to skin-paint cellmates and maintain position, too. The Pacer Crag Block 30 model KC-135s are equipped with GPS, as are all KC-10s. This technology allows for greater flexibility when faced with routing changes when compared to INS-only aircraft (KC-135E). Pilot workload is reduced since the almost constant entry of waypoints is no longer required. Moreover, with the advent of ETCAS, the Block 30 Pacer Crag KC-135s and equipped KC-10s have the ability to "tag" formation members. This feature is immeasurably helpful when in formation, providing increased situational awareness for all formation members and supplemental station-keeping.

Air refueling and en route formation for both the KC-10 and KC-135 are the same and visual references for spacing are similar as well. While the departure portions of the flight will be challenging, the air refueling portions will pose additional problems. Not only are you communicating within the formation, but receiver aircraft are thrown into the mix. Determining altitude blocks that afford safe separation between refueling cells and appease ATC can be a daunting task. Not only will vertical separation be required, it would be a smart move to have lateral separation as well. Break the formation into smaller cells during air refueling and space those cells 5-15 miles in trail when accomplishing refueling. This will reduce the likelihood of mass confusion during a breakaway and each smaller cell will be operating in an arena that is more standard and manageable (i.e., two tankers and three receivers versus 8 tankers and 12 receivers). In addition to the spacing provided by flying in trail, this technique allows the formation to better avoid weather when compared to standard echelon. A large formation in echelon is limited in maneuvering capability and may (probably will) exceed the lateral width limitations of a formation as set forth in FAA Order 7610.4J (5 NM) when operating in FAA-controlled airspace.

As you can imagine, this article could have covered more topics than you have the patience to read. I elected to address areas that have caused confusion in past mixed operations and need to be part of the planning process for a large, mixed-cell operation. If nothing else, the discussion will jog your memory when you're planning a monster fighter drag with dissimilar tankers in your formation or bring up some good "There I was …" stories in your squadron. We've all been there before…flying the aircraft, talking to ATC and on interplane, skin-painting cellmates, running checklists, and avoiding weather to make the mission happen. It's challenging, but very rewarding when carried out successfully. We'll see you out there, and by all means, fly safe! ✈

While flying the formation, not only are you concerned with keeping your jet where it needs to be, it's imperative to remain situationally aware of the position of your cell mates.



Aerodynamic Effects on the Air Refueling Platform

MSGT GREG CONRAD
CASTLE AFB CA
FLYING SAFETY, FEB 94

Relatively speaking, the airflow produces an upwash ahead of the aircraft and a significant downwash behind it.

All of us (tanker pilots, receiver pilots and boom operators), at one time or another, have either experienced a rough day on the air refueling (AR) track or even, perhaps, an air refueling mishap. We can't help but wonder why things happened the way they did. Receiver pilots often question the tanker pilot's abilities or even their own. The boom operator comments on how much of a cowboy the receiver is and to be ready for anything to happen. But, how many of us really stop to analyze the platform and understand the variables involved?

The variables I'm going to discuss are the tanker and receiver aerodynamic effects and boom effects. In discussing these variables, I'm hoping to give you a better understanding of what happens to the airflow around two aircraft during air refueling and how the position of the boom affects the air refueling platform. With the help of KC-135 and B-52 instructor pilots from our Central Flight Instructor Course (CFIC), I hope you receive some valuable information.

I'd like to start out with some excellent information I found when researching this article. In a *Combat Crew* magazine (February 1985), I found an article entitled "Those Interrelated Aerodynamic Effects," dealing with our very subject. The information it presents is just as critical today as it was then.

Upwash, Downwash, Bernoulli

To understand what's happening during air refueling, we need to understand a little about upwash, downwash, tip vortices, and some of the old Bernoulli's theory about pressure differentials. As an aircraft produces lift, it affects the airflow around it. Relatively speaking, the airflow produces an upwash ahead of the aircraft and a significant downwash behind it.

Remember last summer when you were whistling down the highway and you noticed a butterfly about to become a hood ornament on your fresh wax job, but that young butterfly was mysteriously lifted over your car? If you had looked in your rearview mirror, you would have noticed the said butterfly, on the outer edges of maneuvering flight, as he suddenly returned to this original altitude.

What caused this phenomenon? Your car was acting as an airfoil. The airflow directly in front of your car was directed upwards and back, creating a backwash. Additionally, as the airflow passed over the rear of the car, downwash returned the butterfly to his original altitude.

When a wing produces lift, a pressure differential exists between the upper and lower surfaces. At the wingtip, this pressure differential creates components of spanwise airflow. On most large aircraft, the lateral flow developed at the tip is quite strong, and a rather strong vortex is created.

For conditions of positive lift, this vortex has a twisting component toward the aircraft centerline as it moves (relatively) down and aft of the wing. According to Bernoulli, the above-mentioned pressure differential is due to the velocity differential above and below the wing.

By now, you're thinking, "All this is really fine, but how does it affect air refueling?"

Normal Closure

Consider first the normal air refueling closure from precontact to contact. We all know what happens to our airplanes, but why does it happen? Ask any tanker driver why his plane is affected, and he will tell you, "Receiver bow wave (upwash)," and he is right, partially. Ask any receiver pilot why his airplane is affected, and he will tell you, "Tanker downwash." He is also right, partially.

Actually, as the aircraft come in close vertical proximity, the upwash, downwash, and, to a lesser extent, the tip vortices of both airplanes are affected. From the tanker viewpoint, a receiver closing to the contact position causes a change in the vertical component of the upwash and downwash which is not unlike ground effect.

The tanker wants to pitch down as it does when entering ground effect (nose-up trim is required). Induced angle of attack is reduced just as it is in ground effect (thrust required is reduced). In fact, it has been shown in some conditions of flight (climb, for example), the increased parasite drag of boom extension is more than compensated for by the reduction in induced drag due to the receiver in contact, causing "ground effect."

From the receiver point of view, tanker downwash causes the airplane to want to pitch down and slow its rate of closure. The magnitude of these effects depends primarily on the rate of change of the upwash and downwash on both airplanes. This rate of change depends on the speed and relative angle the receiver takes.

The receiver closing very rapidly will obviously have a more rapid and dynamic effect on the tanker. The receiver who closes very low and then tries to pop up to contact, as well as the pilot who tries to close very high and level, causes a more rapid and dynamic change on the tanker because the receiver bow wave (upwash) and tanker downwash are entered suddenly rather than gradually.

Slow closure is a very wise technique. As the receiver achieves contact, he notices the pitching moment caused by tanker downwash has dissipated considerably. If the receiver should continue on beneath the tanker, he will then notice the pitching moment begin to increase again, only this time in the NOSE UP direction!

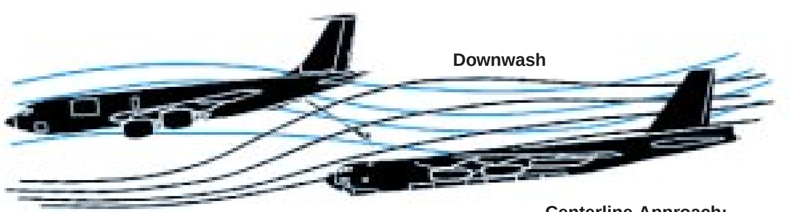
Centerline Underrun

If the receiver continues to underrun the tanker, the aerodynamic effects of the downwash will continue to change. Downwash will not affect the tanker or receiver significantly until the receiver aircraft's fuselage and wings near vertical overlap.

At this time, the Bernoulli effects begin to lower the pressure between the two aircraft and will actually draw them together. The tanker autopilot altitude hold feature, if engaged, will sense this decrease in pressure at the static ports as a climb and will command a pitch down in an attempt to maintain a constant pressure altitude.

This situation will almost invariably result in a midair collision since the only way to separate the aircraft vertically would be for the receiver to lower his nose while the tanker raises his nose in an attempt to compensate, resulting in the tail sections rapidly moving towards each other.

As the aircraft come in close vertical proximity, the upwash, downwash, and, to a lesser extent, the tip vortices of both airplanes are affected.



Centerline Approach:
As the receiver aircraft closes, the tanker downwash and the receiver bow wave influence both aircraft causing the nose to drop and the tail to rise on each of them.

Centerline Underrun:
As the receiver aircraft undershoots the tanker, the downwash moves aft causing the receiver's nose to pitch up while the receiver's bow wave pushes the tanker's tail up.

continued on next page

Lateral Underrunning:
Because of the changing angle of attack caused by the downwash off the tanker's wing, the receiver's wing under the tanker generates less lift while the receiver's wing in the free air generates more lift. The receiver aircraft will, unless corrected, roll up towards the tanker.

Lateral Underrun

Let's consider next what would happen if the receiver noticed a centerline underrun developing and attempted to offset himself laterally to avoid the adverse effects noted under the centerline underrun. As the wing of the receiver moves out of the downwash effect created by the tanker, the local angle of attack of the wing in the clean air will increase and generate more lift, attempting to roll the receiver toward the tanker. As more of the wing enters the undisturbed air, the forces build at a rapid rate.

Without immediate action on the part of the receiver pilot, the receiver aircraft may actually turn into and strike the tanker, or possibly accomplish a barrel roll-like maneuver over the top of the tanker.

Don't forget, the receiver is going to be reacting to the tanker's movements while the boom operator is trying to make contact.

Breakaway

A properly executed breakaway (anybody can initiate one) is a good remedy for conditions leading to the above situations. However, an improperly executed breakaway may serve only to compound the problem. Remember, separation is the objective!

Tanker drivers, don't be in a big hurry to increase your pitch attitude. Increased pitch can lower your tail and decay airspeed. Receiver drivers, don't be in a big hurry to dump the nose. Your tail will come up, and even with the power at idle, airspeed can increase. Booms, make sure your "Cleared to climb" call is *not* automatic.

Although it really isn't important to know Venturi and Bernoulli developed these theories, an understanding of the principles involved can help recognize a potentially hazardous situation soon enough to recover. An understanding of these principles can also help us to visualize what "Fred Boeing" is talking about when he tells us, "It is unsafe to fly two aircraft in close vertical proximity because of the magnitude of interrelated aerodynamic effects."

Lastly, I'd like to discuss boom effects. I found some excellent information while researching in another *Combat Crew* magazine (January 1987). The article, "Boom Effects," explains the last variable of the air refueling platform.

Boom Effects

Now, everyone knows what a primary flight control surface is, right? Ailerons, spoilers, elevators, rudders, etc. But did you know the KC-135 comes equipped with a secondary flight control known as "the boom"? If you think about it, the boom is really just another rudder, and in some ways, it can even act as a throttle control!

Don't believe me, huh? Well, I'll explain a couple of the air refueling demos we do at the Central Flight Instructor Course and, hopefully, show you how these "boom effects" can affect your performance during air refueling operations.

Boom Turn

Earlier, I said the boom is just another rudder. To prove this, we do a simple maneuver called a boom turn, in which we turn the tanker with the boom. The boom is lowered to 30 degrees elevation and then flown to 8 degrees left or right (depending on which way you want to turn). The tanker pilot simply maintains a neutral yoke. With the boom positioned at an azimuth limit, the tanker will roll into a turn without any problem. Then to roll out, you just fly the boom in the opposite direction.

So what's this got to do with refueling? Not much, if the tanker has its autopilot on, because the autopilot compensates for the boom's effect. However, if the tanker has its

Boom Turn:
Swinging the refueling boom eight degrees to the left or right of the centerline with the controls neutralized causes the boom to act as a rudder and will turn the aircraft towards the side the boom is moved.

autopilot off, there can be some complications.

If the receiver comes in off centerline, and the boom operator keeps the boom at 0 degrees azimuth until the receiver closes to the contact position and then swings the boom over to make contact, the tanker pilot had better be ready to counteract the rolling motion induced by the boom. Don't forget, the receiver is going to be reacting to the tanker's movements while the boom operator is trying to make contact.

Night Air Refueling

What about night refueling? The Dash-3, the AR manual for KC-135 operations, tells boom operators to "maintain the boom in a position that will prevent the boom nozzle light from distracting or blinding the receiver pilot." By swinging the boom to one side to keep the nozzle light away from the receiver pilot, the boom could destabilize the tanker's platform, which, in turn, causes the receiver to destabilize prior to getting a contact.

So what's the answer? First, for receiver pilots, try to come in on centerline as much as possible. Second, for boom operators, if the receiver does come in off centerline, tell your pilots so they will be ready to correct any changes caused by the boom. If you're flying at night, ask the receiver where he wants the nozzle light (emission control permitting). If he has no preference, try to keep it on centerline. Most heavy drivers really won't be distracted if you keep it right up the middle.

Limit Demonstration

Now, let's talk limit demonstrations. The boom is going to have the same effect whether there is a receiver hooked up or not. Receiver pilots can destabilize the tanker's platform by moving out to an azimuth limit too quickly. Keep your rate of movement slow and steady when going to the azimuth limits, and keep it slow and steady when coming back to center.

Everybody knows unannounced power changes during AR cause problems, right? Did you realize the receiver's position in elevation can cause the same effect as a small power change while in contact?

One of the demonstrations we do to show this is called a "receiver no-power limits" demo. Both tanker and receiver have autopilot on, in contact with the receiver stabilized at 0 degrees azimuth, 12 feet extension, and 30 degrees elevation. The receiver then moves up to 22 degrees elevation. This reduces the amount of the boom hanging in the slipstream, which, in turn, reduces the amount of drag on the tanker. As a result, the tanker increases airspeed slightly, and the receiver moves aft.

When the receiver reaches 15 feet, he moves down to 30 degrees elevation and stabilizes at 16 feet. The receiver will then go down to 38 degrees elevation, putting more of the boom in the slipstream, which, in turn, puts more drag on the tanker. Yes, you guessed it, the tanker slows down and the receiver moves forward. When the receiver reaches 9 feet, he will move up to 30 degrees elevation and stabilize at 8 feet. All of this movement was accomplished without any changes in throttle position on the tanker or receiver.

So, what's this go to do with "real" refueling? How many receiver pilots tend to come in low during night refueling? It's a tendency many receiver pilots have because there are fewer visual cues available at night to aid in recognizing the effect of the tanker's downwash. The problem with this situation is it could set you up for trouble.

If the receiver comes in low, the boom operator may have a tendency to start lowering the boom in anticipation of the receiver reaching the contact position. To make things worse, the receiver may stagnate somewhere between 10 to 20 feet and add just "a little bit" of power to get through "the downwash." The result is a fast closure rate hard to see at night. How many times have you gotten a contact at night and almost immediately received a "back 2, back 4" correction from the boom operator? Sound familiar?

This same effect could affect our limits demos when demonstrating the upper and lower elevation limits. If you stay at an upper or lower limit for any length of time to point out references, don't forget what the boom position is doing to you, especially on lower limits!

The secret to staying ahead of these effects is realizing they exist and what they are trying to do to you. Booms, keep your pilot informed of the receiver's position, both prior to and during contact. Receiver pilots, realize it may not be all your fault! Some of the problems you may be experiencing during AR may be a combination of these effects. Tanker pilots, be aware of what "secondary flight control" can do to you and be ready for it. Fly safe. ✈

If the receiver comes in low, the boom operator may have a tendency to start lowering the boom in anticipation of the receiver reaching the contact position.

USAF Photo by SrA Jeffrey Allen

The tanker provides air refueling support, eliminating the need for the fighters to make numerous fuel stopovers.

Coronet Planning

CAPT MIKE BUTLER
9 ARS
TRAVIS AFB CA

A "Coronet" is a mission in which a tanker escorts fighter aircraft as they deploy between bases. The tanker provides air refueling support, eliminating the need for the fighters to make numerous fuel stopovers. For tanker aircrews, Coronets are among the most challenging and enjoyable missions. Tankers also aid in weather avoidance, oceanic navigation and communication, and command and control of the mission.

Typically, Coronets or "fighter drags" are in support of Air Expeditionary Force (AEF) swapouts, exercises, and wartime deployments. A single Coronet mission, such as an AEF swapout in Southwest Asia can involve several tankers escorting anywhere from two to six fighters each.

These missions can be extremely complex. It's very common to see multiple join-ups with other tankers and fighters, oceanic flying, coordination with foreign air traffic controllers, and different airfields. Throw in bad weather and maintenance problems, and you've got a mission that will demand your utmost skill and flexibility. As with most military operations, planning is key. During your mission, you'll need all available brain cells—and thorough mission study and flight planning frees up brain cells allowing more concentration on the task at hand.

One of the first things to do is to talk to your tanker planner. The Current Operations Division of the Tanker Airlift Control Center (TACC) is a good place to start. Current Ops will be able to put you in touch with the tanker planner. The planner will give you specific information on your mission and may have the preliminary package for you available on the internet at the Current Ops Web site (https://tacc.scott.af.mil/directorates/current_operations/xook/xook.asp). This package will give you your itinerary, destinations, flight plan, fighter info, fuel times requirements, an Altitude Reservation Approval Request (APREQ), and a communications/rendezvous plan. This will be your first good look at what you'll be doing.

Your next step will be to gather information about your routes and destinations via your flight planning documentation. This step includes (but isn't limited to) getting an Airfield Suitability and Restrictions Report (ASRR), IFR Supplement, Area Planning, and approach plates. It's also a good idea to do a preliminary check of the weather and NOTAMS at these destinations. You may find runway closures, new obstructions, or other items that might limit your ability to operate out of these fields.

Many times, one of your stops will be at a fighter base. Keep in mind these bases are used to handling fighters, so marshallers, POL and Transient Alert folks may not be accustomed to the requirements of large aircraft. Also, don't forget to check out runway length and weight bearing capacity, runway and taxiway obstructions, fuel availability, and departure obstacles. If you're arriving at the fighter base from overseas, don't expect 24-hour customs and agriculture like most AMC bases.

If you're lucky, a fighter representative will meet you before you begin the first leg of the fighter drag. The representative will tell you the plan for the next day. Usually, this will involve the fighter brief. You will want to be there, so find out where and when it is (don't be late!). You can also pass on any critical information, for example, your max fuel load if you will be weight-limited out of that field.

Speaking of fuel, it's obviously one of the most important items to consider during the planning phase. Usually the planner will tell you what fuel load your aircraft will have departing each base. You can modify this based on your needs. I don't want to get the fuel conservation folks all spun up, but I almost always put on more gas if I can. Almost every Coronet I've been on has some random element (weather, field closure, etc.) that causes you to burn more gas than you thought you would. I'd be very conservative here; Coronets are extremely complex—more fuel gives you more options when the chips are down.

For the fighter brief, if you will get one in person (as opposed to over the phone), don't forget to take that into account for your preflight timeline. A fighter brief generally lasts 20 to 30 minutes. During the fighter brief, the delivery control officer will brief the tanker and fighter aircrews together on the day's plan. This will include the timeline, taxi plan, comm/rendezvous information, weather, NOTAMS and divert information. Make sure you have any questions cleared up before you leave the brief. Check your International Flight Plan (DD-1801), Altitude Reservation (ALTRV), and computerized flight plan to make sure they agree.

If you're departing in formation with other tankers, you'll need a few minutes to complete your cell brief. You may lead a formation, so be prepared to give the brief using your local formation brief guide. If you're in a mixed KC-135/KC-10 formation, it's a good idea to review mixed cell formation procedures from your air refueling technical order.

Determine whether the fighters or tankers depart first. Normally, the fighters will take off first. If the mission is cancelled after the tankers depart, it can take hours for the tankers to get rid of their excess fuel to achieve a safe landing weight. This could result in a major mission delay.

Finally, consider what you will do if there's an emergency en route. Typically, if the tanker has an inflight emergency and aborts, the fighters will accompany the tanker. If a fighter must divert, there should be a detailed plan if the fighter will divert alone, with another fighter, or with the entire package. For us tanker folks, during flight we should always keep track of where the closest suitable divert is. By "suitable," I mean you have already checked the NOTAMS, weather and other factors to make sure you won't send a broken fighter to an airfield he can't use.

Finally, once you've got a good plan together, execute it! Fly your planned speeds, offload your fragged fuel at the times specified in your flight plan and always think ahead. Keep a good weather watch ahead. If things get bad, know when to call "knock-it-off." Watch out for get-home-itis. Oh, yeah, once you're back home and post-mission crew rest is done, let your planners know how things went and how they can improve.

Fly safe, have fun and remember—Nobody Kicks *ss Without Tanker Gas! NOBODY!

Coronets are extremely complex—more fuel gives you more options when the chips are down.

USAF Photo by SrA Jeffrey Allen

Tanker Power Management

At CFIC, we believe poor power management by the tanker pilot is a common, but not easily recognized, cause of many problems during air refueling operations.

CAPT DAVE CANTOR
CASTLE AFB, CALIFORNIA
FLYING SAFETY, FEB 94

Three hours of night refueling in IMC conditions—not the best of scenarios, but the receiver has several pilots on board who need to update night air refueling currency. Two hours into the refueling, pilot no. 4 is finished and the receiver backs out for another seat swap. Due to limited visibility, the receiver only backs out to 300 feet.

Meanwhile, the tanker pilot realizes his airspeed is 5 knots fast. The receiver will never notice a slight power change, so the tanker pilot reduces power 1/4 knob width on all four throttles. Nothing happens at first, but 15 seconds later, the distance between the two aircraft starts to decrease.

The closure isn't recognizable at first, but as the receiver aircraft approaches 200 feet, the boom operator notices what appears to be a normal closure to the precontact position. The tanker airspeed has decreased 2 knots, but the receiver pilots are still busy with their seat swap and don't notice the closure. At 100 feet, the closure rate looks higher than normal but not unsafe, so the boom operator assumes the receiver will slow the rate of closure momentarily.

The receiver pilots now notice the decreased distance between the two aircraft and make a slight power reduction. At this point, *a midair collision is unavoidable.* At 50 feet, the closure rate is enormous, but there is nothing either plane can do to overcome the momentum. Total decrease in tanker airspeed: *5 knots.*

Air Refueling Incidents

What do you think is the most common cause of air refueling mishaps? Turbulence, clouds and darkness are among the causes cited by many pilots and boom operators. At CFIC, we believe poor power management by the tanker pilot is a common, but not easily recognized, cause of many problems during air refueling operations.

The following discussion will cover some recommended techniques for tanker power management during air refueling along with a review of some *CFIC-only* demonstrations we use to support our recommendations.

Mission Planning

When should crews begin to prepare for the air refueling operation? How about during mission planning! This will be easier for those crews who mission plan the day before the flight, but the point is for the tanker crew and receiver crew to talk directly with each other about the mission.

Among the topics of discussion: When is the best time to make tanker power changes, which Emission Control (EMCON) option will be used, and under what circumstances will the tanker break radio silence to announce changes in power.

The bottom line is the tanker and receiver do not refuel *against any other* aircraft. The tanker refuels *with* the receiver, and any prior coordination which can take place to make the operation easier is worth the effort.

When to Make Tanker Power Changes

So when is the best time to make tanker power changes? Obviously, the best plan is to have the airspeed and power stable before the receiver closes inside a quarter of a mile, but after that point, most receivers would prefer tanker power changes be withheld until the receiver is in the contact position. If the tanker is off the planned airspeed, a radio call will allow the receiver to adjust the closure rate.

There are at least three reasons why this is much easier for the receiver to deal with than a tanker whose power setting is constantly changing. First, from 1/4 mile into 100 feet, the closure rate is very difficult for the receiver to judge (especially at night or in the weather). The receiver is counting on a constant platform while trying to judge the closure. If the tanker is slowly accelerating or decelerating, it doesn't matter as long as the relative rate of closure isn't changed by the tanker.

Second, when closing from 50 feet, the receiver plans on making the power changes required to set up the desired closure rate and to overcome the downwash from the tanker. Any changes in the tanker power setting simply add more variables to this already-difficult part of the operation.

Third, once the receiver is stable in the contact position, it's much easier to recognize small changes in the relative position of the aircraft. Visual references on the tanker and the pilot director lights both contribute to the receiver's ability to make small power changes to maintain position.

When *Not* to Make Tanker Power Changes

What are some additional times to avoid making tanker power changes? Think about manual boom latching and reverse air refueling operations. During KC-135 manual boom latching, the boom operator is exerting extend pressure with the boom against the receiver prior to toggle engagement. The receiver has to add power to overcome this pressure.

How much power? There's no way of knowing since each boom operator exerts a different amount of extend pressure. This maneuver is difficult enough without the tanker adding more complications. During reverse air refueling, a slight amount of retract pressure is held by the KC-135 boom operator to open the tanker bypass valve (this allows fuel to pass from the receiver to the tanker). Although not as significant as manual boom latching, this does require a slight reduction in power by the receiver and would *not* be a good time for power changes by the tanker.

Minimize Tanker Power Changes

Once the receiver is in the contact position, it is still advisable to minimize tanker power changes. The reason is the receiver has to make three power changes for every power change made by the tanker—the first to reverse the adverse trend once it is recognized, the second to overcome the momentum built up during the correction, and the third to stabilize back in the appropriate position. We use a CFIC maneuver entitled "tanker power management" to demonstrate this concept.

With the receiver stable in the contact position and the receiver's throttles locked, the tanker adds a quarter knob width of power on two throttles. Within 15 seconds, the tanker pulls four feet away, leaving the receiver at the aft limit of the envelope. It then takes two power changes by the tanker to stabilize the receiver. We then reduce the power on two throttles to bring the receiver back to the middle of the envelope (once again using two power changes to stabilize the receiver in the middle of the envelope). The lesson to be learned from this maneuver: Use of known target power settings by the tanker can help to minimize these power changes, thus making life much easier for the receiver.

Air Refueling in the Climb

A maneuver which could happen in the tanker community is air refueling in the climb. What does the receiver care about when the tanker approaches a level-off altitude during air refueling? Some tanker pilots think the pitch change is the important factor, but receiver pilots will tell you they don't even notice pitch changes if they're accomplished smoothly.

The big factor for them is *power changes!* Being able to anticipate the power change makes the level-off much easier because the receiver can make a power reduction along with the tanker, thus preventing a closure from developing when the tanker pulls power back. The same concept applies when departing a level-off altitude for a newly assigned altitude. We recommend the power change be called, with the receiver's acknowledgement being used as the command of execution.

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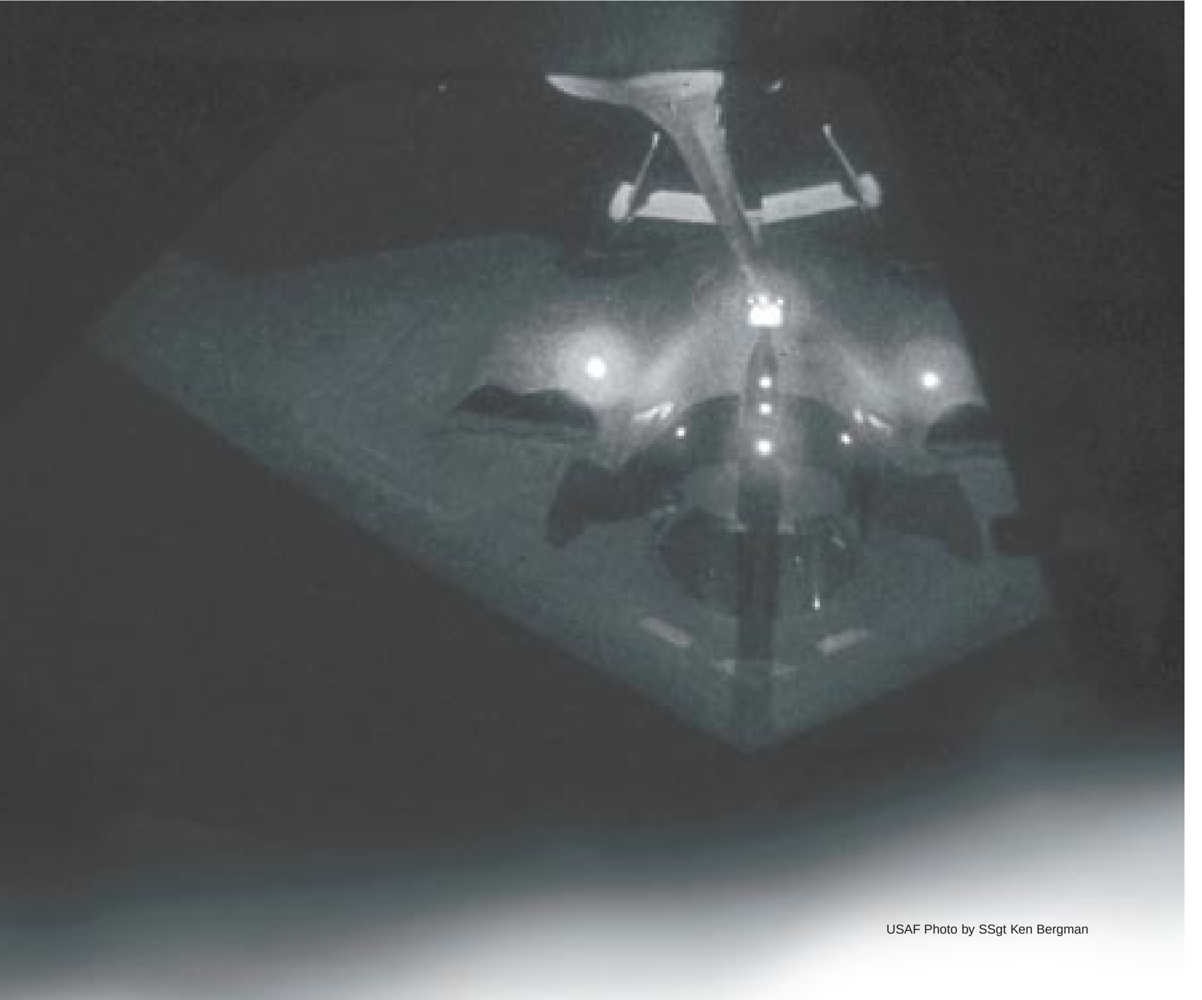
If the tanker is off the planned airspeed, a radio call will allow the receiver to adjust the closure rate.



USAF Photo by SSgt Ken Bergman

We recommend the breakaway be called but the tanker only add symmetric thrust (if any thrust is added at all).

Engine Failure

What should the tanker do if an engine fails during air refueling? KC-135 tech orders tell us to execute a breakaway, but is it necessary to add a lot of power immediately (particularly asymmetric power)?

During a CFIC maneuver entitled "engine failure series," we demonstrate, with one engine pulled to idle, it takes up to five seconds before the receiver even notices a significant change in position. The point? The loss of an engine isn't a life-threatening event.

We recommend the breakaway be called but the tanker only add *symmetric* thrust (if any thrust is added at all). Allow the *receiver* to use reduction in thrust to gain separation between the aircraft.

There should be no hesitation to do this since the receiver is the aircraft which causes lateral separation to occur during the first few seconds of a breakaway. (Due to momentum and engine spool-up time, it takes much longer for the tanker to accelerate than the receiver to slow down.) Using this technique will make the recovery from the engine failure much easier for the tanker while getting the receiver away in case engine parts are falling off the tanker.

Talk to Each Other

The most important thing we can all do to improve safety during air refueling is to talk to each other. This means before, during, and after the mission.

EMCON procedures are important in tactical situations, but the mission will also be stopped by an inability to accomplish the air refueling. Do what you have to do to maintain security, but don't sacrifice aircraft safety in the process. Discuss all possible contingencies prior to the mission, then talk when necessary during the flight (using the boom interphone if it's available).

Talking after the flight can be very helpful if the crews honestly discuss whatever problems were encountered. If your refueling partners do something to make life hard, they will continue to make the same mistake unless you tell them about the situation.

It may require some effort to communicate with non-collocated crewmembers, but the effort will be worth it if we can improve the performance of all crewmembers involved in air refueling operations.

USAF Photo by SrA Jeffrey Allen

COMBAT TANKING

LT Randy Rogers, USN
VAQ-134

It was the second week of Operation Allied Force. We were getting comfortable with the operation, maybe too comfortable. The mission for the day was the same as the day before, and the day before that. It involved multiple refuelings and multiple vulnerability (vul) windows to cover. The entire flight would be almost seven hours long.

We were leaving the AOR after our second vul window and proceeding to the tanker. The route to the tanker was becoming very familiar and involved transiting through several altitude blocks. It was a clear day and we had no problems seeing the other aircraft. I looked down to check our fuel state, and when I looked back up I saw a flash go by the windscreen. Looking in the mirror I saw the tail end of an F-16 doing a roll. When I got my voice back and my heart started beating again I informed the crew that everyone should be looking out for traffic because we almost had a midair with an F-16. ECMO3 quickly responded with “Is that what just flashed by our canopy?”

How is it that a single-seat fighter almost hits an airplane with four crewmembers? Granted that the two crewmembers in the back cannot see anything, but what about that aircraft that is overtaking you? Or the one that is approaching from your seven to ten o’clock? A quick word from your backseater can save the entire crew. It may have to be a simple command like BREAK Left/Right, CLIMB, or even DIVE. You probably will not have time to say “Traffic, nine o’clock, level.” We certainly did not have time in our case.

So what did we do wrong that put us in this position? The main error that we made was that we were transiting through the striker’s altitude block to get down to our tanker altitude. This transition was necessary, but we were doing it at about 1000-2000 feet per minute. When you have to transition another aircraft’s altitude block you should do it as quickly as possible and get down to the safe altitude block that you have been given.

The see and avoid principles always apply, but when you are in high density areas such as a tanker track, someone should always be looking outside. With two aircraft approaching head-on at 400 KIAS, you have 800 KIAS of closure. That means that it takes about one minute to cover 13 nautical miles. How far away can you see an F-16 approaching you head-on? It took me only a couple of seconds to check our gas, but if the F-16 pilot had been doing the same thing it would have been five lifetimes. What was ECMO1 doing? Did I tell him I was going to be inside the cockpit and to keep an eye out? No, but I should have and I do now.

We all have to remember that anytime you strap on your flight gear, lives are in harm’s way, be it an actual combat mission or a simple ferry flight. The other thing to remember is to avoid complacency at all costs. It may take a wake-up call like this to make you realize that you are getting complacent. I hope you get that wakeup call rather than a permanent dirt nap.

(VAQ-134 is a US Navy Expeditionary EA-6B squadron.)

I looked down to check our fuel state, and when I looked back up I saw a flash go by the windscreen.

SMSGT JAMEY M. WILLIAMS
CHIEF, USAF OPERATIONS AND PROCEDURES
HQ AFFSA/XAOP

A1C Dawn N. Bachman (Tower, Local Controller), 49th Operations Support Squadron, Holloman AFB, New Mexico.

While working as Local Controller in Holloman tower, Airman Bachman directed an F-117 in position to hold on runway 25 and cleared another F-117 to land on intersecting runway 16. She then noticed the holding F-117 begin its takeoff roll without clearance. Airman Bachman immediately instructed the arriving aircraft to go around and averted a catastrophic incident, saving two lives and two F-117 aircraft worth $104 million.

SSgt Timothy J. Enright (Tower, Local Controller), 9th Operations Support Squadron, Beale AFB, California.

While working in the Beale tower and despite poor visibility due to rain, Sergeant Enright observed an IFE U-2 flying dangerously close to the ground. He called Sacramento Approach to bring the situation to their attention; however, their controllers said they weren’t in communication with the pilot. Realizing the criticality of the situation, Sergeant Enright immediately transmitted a “low-altitude alert” warning to the U-2 pilot on “Guard” frequency. The pilot replied that he did not have the airfield in sight. Sergeant Enright immediately turned up the runway lights and suggested a heading to help the disoriented pilot establish himself on the final approach course. Once these actions were taken, the pilot reported the airfield in sight and safely landed the high-value aircraft with less than five minutes of fuel remaining. Sergeant Enright’s quick reactions to a hazardous situation allowed for the safe recovery of a $21 million aircraft and an irreplaceable crewmember.

F-15

USAF Photo by MSgt Thomas Meneguin

LT COL KEN BURKE
HQ AFSC/SEFF

FY00 presented a few unusual incidents in the F-15's safety history. A statistical comparison of FY00 to previous years is not applicable, due to changes in the bean-counting ROE. The stats say we suffered three Class As and 21 Class Bs. That Class B number is well above the historical look.

One Eagle was 'lost' during a DACT engagement. High AOA maneuvering, possibly with a fuel imbalance, and the aircraft departed controlled flight into an erect spin. Good news: The pilot ejected successfully. This scenario has occurred numerous times in the past. Inappropriate attention to fuel state has been cited before as a contributor to unrecoverable departures, especially when the pilot suddenly becomes offensive or defensive.

Another near-catastrophic Class A occurred during landing. Unknown to the crew, the main gear connecting link failed sometime in flight. When the gear extended, it didn't rotate 90 degrees, as designed. So, with the tire and wheel perpendicular to the aircraft direction of travel, and the cockpit indication showing three down-and-locked, the landing quickly became a nightmare. After the tire blew, the lower strut assembly broke off, and the aircraft slid off the runway. Then the other main gear collapsed and the wingtip dug into the soft earth, causing the aircraft to cartwheel and break apart. The injuries sustained were significant, but could have been worse. Please refer to the SIB report for their recommendations on how to reduce the likelihood of this recurring.

The third Class A was an engine-confined damage incident that barely broached the $1 million mark.

Of the the 21 Class B mishaps reported, 13 were engine-confined damage or FOD-caused. In some cases the pilot never realized he had an incident because there was no obvious indication of engine degradation. Birds down the intake caused two additional Class Bs, damaging the engines.

The other Class Bs included two more instances of the wing pylon aft hook failing and the loaded pylon departing the aircraft, damaging the wing as it left. Flight loads testing has been accomplished and the results are expected soon. Redesign of the hooks may be an outcome of the test results. Meanwhile, the field is receiving replacement hooks.

There was another incident where a main landing gear failed to rotate to aircraft alignment during gear extension. This time the culprit was a corroded upper bungee cylinder that prevented the normal twist action. The pilot in this case made an AB go-around. He then made a successful approach-end cable engagement.

An E model suffered a scraped belly during a night visual pattern touch and go.

A C model experienced a 13th-stage compressor diffuser duct failure. Hot bleed air into the engine bay produced further aircraft damage.

The last incident occurred after a high-speed abort for a canopy problem. The post-abort tire fire contributed to further aircraft damage.

Good news for last year includes: no fatalities and no Class A or B midairs. Maintaining high SA, and adherence to the rules will increase the likelihood of extending that streak. Otherwise, I recommend reviewing the message reports from these mishaps to gain greater insight into how you can prevent a future smoking hole.

After the tire blew, the lower strut assembly broke off, and the aircraft slid off the runway.

USAF Photo by TSgt Michael Featherston

FY00 Engine-Related Mishap Summary

> *In FY00, engines were causal for only 17.6% of all destroyed aircraft.*

FBILL BRADFORD
RICH GREENWOOD
JOHN MAYNARD
MAJ STEVE ROSE
HQ AFSC/SEFE

FY00 Engine-Related Mishap Overview—A Look at the Numbers

So how did we do this past Fiscal Year with respect to aircraft that were destroyed due to engine problems? Quite well, as you can see from Figure 1, which shows the percentage of all destroyed aircraft mishaps that were engine-related for the past seven years. In FY00, engines were causal for only 17.6% of all destroyed aircraft. In fact, over the last seven fiscal years, we've only had one year that was better from a percentage standpoint, and in that year, FY94, we actually lost more aircraft due to engines (five) than we did in FY00, when we lost only three aircraft due to engine problems.

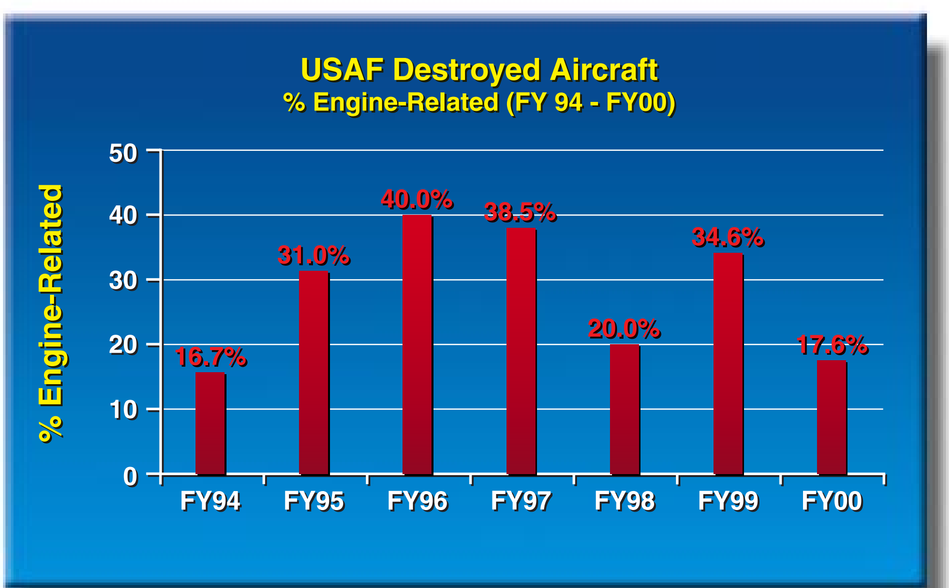
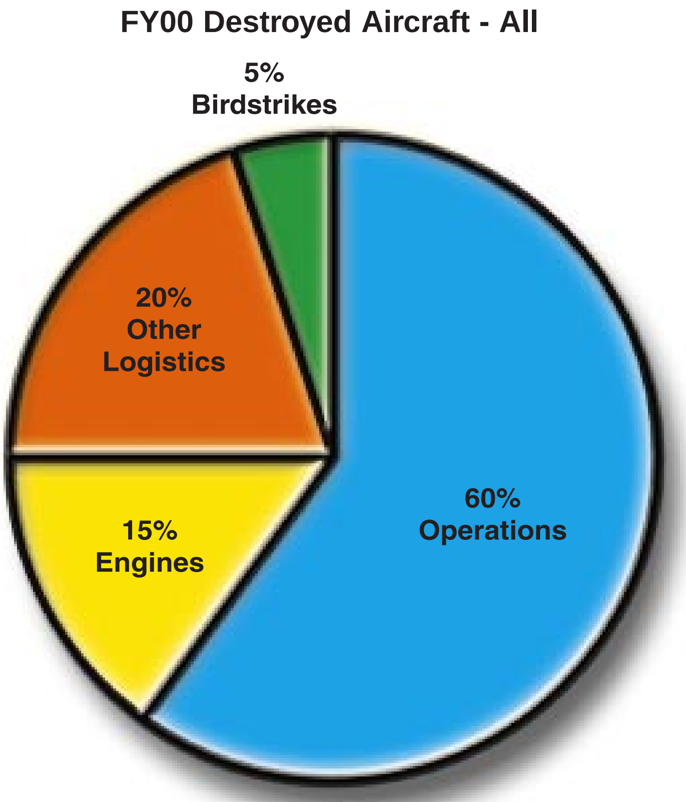


Figure 1

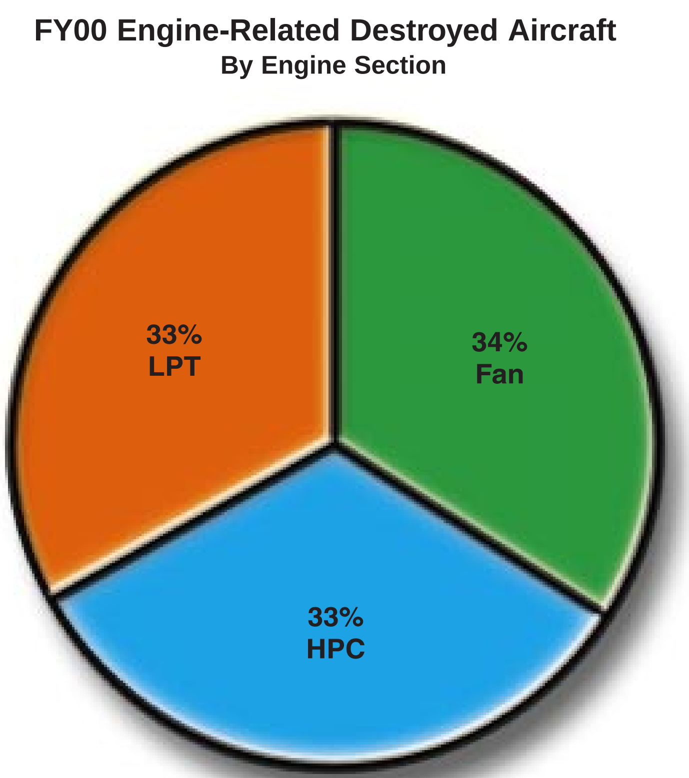


Note: Some mishaps have more than one category.

Figure 2

If you're curious as to the other categories that caused the USAF to lose valuable aircraft assets, take a look at Figure 2. "Operations" was the leading category at 60 percent with Engines (15 percent) and Other Logistics (20 percent) running a distant third and second place, respectively. It was a very good year if you were an engine troop, but not so hot from the Operations viewpoint.

It was a very good year if you were an engine troop, but not so hot from the Operations viewpoint.



Since we only had three engine-related mishaps that resulted in destroyed aircraft, the chart depicting the contributing factors becomes somewhat simple to create and equally simple to study. As you can see, the failures appear to be random in nature with none falling within the same area—one Low Pressure Turbine (LPT) failure, one High Pressure Compressor (HPC) failure, and one Fan failure, yielding a very equally distributed pie, as depicted in Figure 3.

Figure 3

continued on next page

F-15 and F-16 Mishap Rates

Before we talk about each individual mishap, let's take a look at the F-15 and F-16 engine-related mishap rates. Table 1 shows how we did this past FY as compared to the two previous FYs in the F-15 world. Again, we didn't lose a single F-15 due to an engine problem in FY00, thereby duplicating our success of FY99. Way to go, troops!

F-15 Engine-Related Destroyed Aircraft Statistics						
Fiscal Year	FY98		FY99		FY00	
Engine	Aircraft Losses	FY98 Rate	Aircraft Losses	FY99 Rate	Aircraft Losses	FY00 Rate
F100-PW-100	1	0.47	0	0.00	0	0.00
F100-PW-220	0	0.00	0	0.00	0	0.00
F100-PW-229	0	**	0	**	0	**
All Engines	1	0.26	0	0.00	0	0.00

** Insufficient flight hours on this engine application to compute a meaningful mishap rate.

Table 1

In the F-16 community we enjoyed similar success given that virtually every category depicted in Table 2 for FY00 shows improvement over FY99. It is especially gratifying to see that the overall rate of destroyed F-16 aircraft due to engine problems is substantially below 1.00, at 0.87 destroyed aircraft per 100,000 flight hours. Again, hearty "congratulations" are due here!

The MP made three airstart attempts, none of which were successful.

F-16 Engine-Related Destroyed Aircraft Statistics						
Fiscal Year	FY98		FY99		FY00	
Engine	Aircraft Losses	FY98 Rate	Aircraft Losses	FY99 Rate	Aircraft Losses	FY00 Rate
F100-PW-200	0	0.00	0	0.00	0	0.00
F100-PW-220	0	0.00	5	3.98	2	1.59
F100-PW-229	0	**	0	**	0	**
F110-GE-100	2	1.34	3	2.04	1	0.74
F110-GE-129	1	1.60	1	1.55	0	0.00
All Engines	3	0.79	9	2.58	3	0.87

** Insufficient flight hours on this engine application to compute a meaningful mishap rate.

Table 2

Destroyed Aircraft by Engine Model

We've pretty much finished with the statistics by now, so let's move on to the summaries of the three aircraft we lost in FY00 due to engine failures.

F100-PW-220 Engine

There are only two destroyed aircraft from engine-related problems this year in the Pratt & Whitney-powered F-16 fleet, a significant improvement over last year. An influx of new hardware into the fleet and diligence in performing engine inspections by maintenance crews are wholly responsible.

The first F100 mishap involved an F-16CG on an air-to-air training mission. During a G-awareness exercise, the MP felt aircraft vibrations. Shortly thereafter, he declared an emergency due to a compressor stall. After selecting SEC (secondary engine control) the ME stagnated. The MP made three airstart attempts, none of which were successful. Approaching the minimum controlled ejection altitude, the MP successfully ejected and was recovered uninjured. The MA impacted the side of a mountain and was destroyed.

Investigation revealed that the initial vibrations were the result of compressor stalls initiated by DOD (domestic object damage) from the liberation of a rear compressor variable vane (RCVV) inlet guide vane (IGV). The RCVVs are movable vanes at the front of the compressor used to control airflow and increase stall margin. One of the vanes had cracked due to fatigue and was ingested into the compressor, resulting in damage to the downstage blades and vanes. The damage reduced the engine's high power stall margin. As the compressor stalled, the Digital Electronic Engine Control (DEEC) responded appropriately by reducing fuel flow and opening the nozzle to recover from the stall. During one of the stall recovery events, the MP selected SEC, which prevented the DEEC from performing its stall recovery function, and the engine stagnated. Transferring to SEC or advancing the throttle in SEC while the engine is stalling will usually result in stagnation. During the subsequent engine stagnation and first restart attempt, overtemperature damage occurred to the high-pressure turbine, reducing the engine's airstart capability.

Laboratory analysis of the remaining portion of the liberated IGV showed it had been cracked during the module's previously scheduled depot inspection and, due to the inspection process in place at the time, the crack was not detected. Damage to the IGV prevented a root cause determination. Both the depot overhaul process and the pilot's emergency checklist have been revised to keep this chain of events from occurring again.

The second F100 mishap occurred over water during an air-to-air training flight. The MP experienced compressor stalls and severe vibrations. During an attempted return to home station, the engine continued to run, but the vibrations increased. The MP decided he couldn't make the base, maneuvered the aircraft to an unpopulated area and successfully ejected. The MA impacted the water approximately one and one-half miles offshore. The MP was recovered uninjured.

Subsequent recovery and teardown indicated the engine suffered low pressure turbine damage, most likely in the 3rd stage fan drive turbine (FDT) blade area. Damage to the blade prevented a root cause determination. The F100-PW-100 / 200 / 220 / 220E engines are currently being retrofitted with more robust FDT blades that resist the higher temperatures of older, less efficient engines. The mishap engine did not incorporate this new, more robust design. Borescope inspection for 3rd FDT blade tip "curl" continues as a risk mitigation action, and awareness training updates are being briefed throughout the field. Efforts are also underway to accelerate the incorporation of the new FDT hardware.

F110 Engine

There were no F110-GE-129 engine-related Class A Mishaps for FY00 and only one engine-related Class A Mishap for the F110-GE-100. This is down from three Class A's in FY99. While some of this decrease can be attributed to new and improved hardware, most of the credit for this improvement must go to the diligent engine inspections being accomplished by your maintenance troops.

The one F110-GE-100-related mishap occurred during a night air intercept mission when the pilot experienced a "bang." RPM and FTIT were winding down and the wingman saw sparks exiting the mishap aircraft's exhaust nozzle. The mishap pilot attempted several air starts with no success and successfully ejected from the aircraft. Inspection of the mishap engine revealed that a first stage fan blade broke off. The fan blade failed in the dovetail shank area, due to an etching process used during blade manufacturing. If this etching process is not properly done, the blade can be arc-damaged, which can lead to blade cracking and eventual failure. This was a known problem and a depot inspection had been put in place to get these suspect blades out of the system. This particular Class A drove a more in-depth field inspection using a one-time ultrasonic inspection and a recurring visual chemical inspection technique. All F110 engines have received an ultrasonic inspection and all engines will be visually / chemically inspected prior to March 2001.

Some Thoughts on Foreign Object Damage (FOD)

We would be remiss in this issue if we didn't spend some time talking about engine FOD. We've seen a definitive increase in the number of FOD mishaps reported through the safety system. It may be that in the past the use of Class J Mishap reporting did allow for more factual reporting of FOD incidents over the past year, but the fact remains: FOD is a very expensive, time-consuming, mission detracting and demoralizing part of our everyday life.

The one thing that sticks out about FOD is that it's preventable. Every day units spend an enormous amount of resources, both in people and money, trying to prevent FOD. We accomplish daily FOD walks of the ramp and shop areas along with the use of sweepers on a continual basis to patrol the taxiways and runway areas. The question here is: "Is it enough?"

continued on next page

If this etching process is not properly done, the blade can be arc-damaged, which can lead to blade cracking and eventual failure.

USAF Photo by TSgt Michael Featherston

Each unit must take an individual look at its own mission, location, operation and base, and develop a "Best Practice" program that suits that particular unit.

We could go over the numbers, show you nice graphs and add up all the dollars for the year, but we think this year it would be a better practice for you to take a hard look at your individual unit's program and processes to see just how you stand. Each unit is different in the Air Force. Each unit must take an individual look at its own mission, location, operation and base, and develop a "Best Practice" program that suits that particular unit. How many FOD incidents did you have? Did you have the right leadership level at monthly FOD meetings? When you drive onto the flightline, how good an inspection are you accomplishing on your vehicle? Most people just look for rocks and stones in the tires. What about the rest of the vehicle? Do you have any loose items in the bed of the truck? How about bobtails and tugs? Are all the safety pins, cables, bolts, brackets and associated towing equipment safe and secure? Do you have total wing buy-in when it comes to your FOD Prevention Program?

As our Ops Tempo increases across the Air Force, we all feel the strain to get the job done and get it done *now*. The problem is that FOD causes us to take one step forward and two steps back. FOD is our enemy, plain and simple. It prevents us from accomplishing the mission in a timely manner. Today, under ever-tighter budgets, there just aren't enough resources to perform costly engine maintenance twice. We constantly ask ourselves, "Why can't I just buy that extra part to fix an engine? Why are we always living on the edge with only enough spares to meet mission requirements, but never enough to feel comfortable and be able to relax for awhile?" You might want to look at

how much time you're spending to fix FOD-caused mishaps and the impact to your unit...

There are two areas that stick out when we review the numbers. First is the number of FOD reports for engines ingesting common hardware. Two incidents that really jumped out at us are a cargo aircraft engine that ingested a bolt, causing over $600,000 in damage, and a fighter engine ingesting a bolt, causing over $500,000 in damage. Why? They both occurred on the first runs after the engines were in the shop for maintenance. The second area is the number of FOD incidents caused by engines ingesting flashlights, ground cords, inlet plugs, headsets, aircraft records and lock pins. When FOD happens, all too often the outcome is a scrubbed mission. There is one thing both of these areas have in common—*they are totally preventable.*

It's plain and simple—FOD *is* preventable! However, each year the dollar and manpower costs remain high with no downturn of FOD incidents in sight. So when you take a look at your mission and the increased Ops Tempo you have to deal with every day, please include an in-depth look at your unit's FOD program and see what role this enemy is playing in your unit. When you find a problem area, or if you have a practice that proves to work, it might be time to get the word out to other Air Force units. Use of a crosstell message, *Flying Safety* magazine article, or even e-mail between safety offices is a good way to help each other prevent a potential FOD incident. Let's work together in eliminating this enemy once and for all. Let's all strive to have a FOD-free 2001!

It's plain and simple—FOD is preventable!

USAF
Class A Flight Mishaps

FY01 Flight Mishaps (Oct 00 - Jan 01)	FY00 Flight Mishaps (Oct 99 - Jan 00)
7 Class A Mishaps **1 Fatality** **7 Aircraft Destroyed**	**6 Class A Mishaps** **4 Fatalities** **3 Aircraft Destroyed**

04 Oct	♣✶	An RQ-1 Predator UAV crashed while on a routine test mission.
12 Oct	♣	An F-16C crashed during a routine training mission.
23 Oct	♣✶	An RQ-1 Predator UAV went into an uncommanded descent.
03 Nov		An F-15C experienced engine problems on takeoff. The pilot successfully RTB'd. Both engines sustained damage from FOD.
07 Nov		The Class A Ground Mishap reported here involving engine/accessories damage to two F-15s serviced from a contaminated oil cart has been downgraded to a Class B Ground Mishap.
13 Nov	♣♣	There was a midair collision between two F-16CJs. Only one pilot was recovered safely.
16 Nov	♣	An F-16CG on a routine training mission was involved in a midair collision.
06 Dec	♣	A T-38A impacted the ground while on a training mission.
14 Dec	♣	An F-16C crashed shortly after departure.
11 Jan	♣	An A-10 crashed short of the runway.

- A Class A mishap is defined as one where there is loss of life, injury resulting in permanent total disability, destruction of an AF aircraft, and/or property damage/loss exceeding $1 million.
- These Class A mishap descriptions have been sanitized to protect privilege.
- Unless otherwise stated, all crewmembers successfully ejected/egressed from their aircraft.
- Reflects only military fatalities.
- "♣" denotes a destroyed aircraft.
- "✶" denotes a Class A mishap that is of the "non-rate producer" variety. Per AFI 91-204 criteria, only those mishaps categorized as "Flight Mishaps" are used in determining overall Flight Mishap Rates. Non-rate producers include the Class A "Flight-Related," "Flight-Unmanned Vehicle," and "Ground" mishaps that are shown here for information purposes.
- Flight, ground, and weapons safety statistics are updated frequently and may be viewed at the following web address: http://safety.kirtland.af.mil/AFSC/statspage.html
- **Current as of 28 Jan 01.**

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WELL DONE AWARD

UNITED STATES AIR FORCE

THE Well Done AWARD

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

CAPTAIN DAVID C. SERAGE

Detachment 1, 366th Operations Group

On 5 February 1998, while staging out of Incirlik AB, Turkey, Captain David C. Serage was leading a two-ship low-level training mission in a Navy EA-6B Prowler. Captain Serage was flying a HARM attack profile timeline when a dozen "goose-size" birds filled the windscreen. After initiating a climb, he felt two distinct thumps. The aircraft immediately shuddered and yawed to the right. The right engine EGT spiked and his wingman reported, "right engine on fire." While climbing to 4,000 feet AGL and shutting down the failed right engine, Captain Serage promptly placed his vector to the pre-planned divert field, Erkilet AB, Turkey. His wingman later reported that half the radome was missing and the right engine had damage around the intake with the fire extinguished. Captain Serage's remaining engine began to compressor stall with visible flames. He initiated a climb to 10,000 feet and prepared the crew for ejection. With the engine beginning to stall and no useable throttle setting, he elected to set it to the military position, which yielded a surging RPM at 70-85 percent. Now at 230 KIAS, the aircraft was losing altitude at a rate of 500-600 feet per minute. At 4,000 feet AGL with this excessive sink rate, Captain Serage and his crew still had 20 more miles and a ridgeline to clear before reaching Erkilet. Captain Serage recognized the ridgeline dropping lower in the windscreen and below his flightpath as he reaffirmed to his crew that he expected to clear the ridge and make the field. After clearing the ridge, his wingman called the runway position at ten miles on the nose. Turkish tower controllers were caught completely by surprise by this American aircraft approaching their field, but Captain Serage was left with only two options—land or bail out. At two miles, he lowered the landing gear, set the flaps to twenty degrees, and lowered the arresting hook. As the runway appeared out of the haze, Captain Serage noticed a C-130 turning on the departure end preparing for takeoff. He quickly and decisively utilized what little remaining speed and altitude he had and side-stepped to the shorter parallel runway, landing with only 4,000 feet of runway remaining. The jet sustained significant damage—both engines were destroyed along with major intake structural damage.

Captain Serage's outstanding airmanship, flying skills, superior planning, crew coordination, and clear thinking during a series of in-flight emergencies not only saved his crew, but also an irreplaceable joint combat asset.


AIR FORCE SAFETY CENTER