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FLYING Safety

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Cover: USAF Photo by MSgt Dave Ahlschwede
Photo Illustration by Dan Harman

UNITED STATES AIR FORCE
FLYING Safety
MAGAZINE

Errata:

In the Annual Mishap Issue (January/February 03, page 38), we listed the Class A mishap rate for the US Coast Guard as 2.93. This was an error; the Coast Guard suffered no Class A mishaps in FY02.

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

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MESSAGE From the Editor-in-Chief

FINI-FLIGHT

As I end my tenure as your Editor-in-Chief of *Flying Safety* Magazine, I wish to take advantage of this position to say a few things. First, I want all the readers of this publication to know that we have a first-rate, professional staff that brings you the finest aviation safety journal in the Department of Defense—and the aviation industry in general. It has truly been my desire, and theirs, over the past 32 months to make a difference. The goal of this publication is to prevent aviation mishaps. We think we do a pretty good job. We cannot do our job here without your help, so please keep your inputs and articles coming. If you have an experience you want to share, a pet safety issue or procedure you want to pass on, let us know. We'll publish it, and we still have a stock of *Flying Safety* Magazine coffee mugs to send you as a thank you.

As I write this, we are engaged in combat operations in Operation Iraqi Freedom and Operation Enduring Freedom. This again entices me to repeat that "The Mission is paramount, and the trick is to do it as safely as possible." The goal of safe operations and mishap prevention is to preserve combat capability. I encourage you to apply sound risk management and risk mitigation to come back safely, and to fly and fight another day.

I am moving on to another assignment, but I will do so as a safety zealot. I know your *Flying Safety* Magazine staff will continue to put the aviation mishap message in your hands every month.

Keep it safe on the flightline and in the air!

Mark K. Roland, Colonel, USAF
Editor-in-Chief

CAPTAIN TYSON HUMMEL
9 ARS
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One of the most challenging decisions you will ever make as an aircraft commander is whether or not to abort your takeoff. If you are ever caught in that situation, it might be the most difficult maneuver you ever perform in the airplane—and all without ever leaving the ground.

This article is about the airmanship involved in the go/no-go decision and how it relates to the KC-10. It's amazing that in hundreds of pages of publications for the KC-10 only one page (Dash-1, pg. 4-92) talks about the takeoff abort procedure, or go/no-go decision, with no mention of what you should be "looking at" or "looking for" as you are rolling down the runway. Here is the Dash-1 guidance:

A. The takeoff is aborted before V_1 *if a serious emergency/loss of thrust occurs.*

USAF Photo by MSgt Dave Ahlschwede
Photo Illustration by Dan Harman

NOTE
Although there may be a number of reasons to abort a takeoff, as you approach V_1 *the decision to abort should be based upon an increased level of criticality. In those cases where the decision to stop or go may be borderline, experience shows that more difficulty is encountered in attempting to abort than in attempting to continue. It is recommended that emphasis be placed on continuing the takeoff in borderline situations.*

That's not really a great deal of information to make a truly informed decision. To say the least, the above statement and note warrant considerable follow-on discussion and training. And somewhere in that follow-on thought you'll need to develop your own interpretation of a serious emergency/loss of thrust and how you'll deal with problems you might encounter. The decision whether to continue or abort a takeoff should be made long before the takeoff is ever attempted. So just what do you consider a serious emergency and why? Have you decided what you will and won't abort for, and when?

Three reasons have led me to my conclusions. First, Boeing published an eye-opening article titled "Practical Applications For Rejected Takeoff Studies" (http://www.boeing.com/commercial/aeromagazine/aero_11/) that goes into depth about the rejected takeoff scenario. The article's basic message is an argument for "going" or continuing the takeoff after 100 knots (absent any serious emergency) and gives statistical numbers backing up that decision. I highly recommend reading it yourself. Here are a few excerpts.

- In fact, in about 55 percent of rejected takeoffs (RTOs) the result might have been an uneventful landing if the takeoff had been continued.
- More than half of RTO accidents and incidents reported in the past 30 years were initiated from a speed in excess of V_1.
- Only slightly more than one-fourth of the accidents and incidents actually involved any loss of engine thrust.
- Nearly one-fourth of the accidents and incidents were the result of wheel or tire failures.
- Above 100 kts the takeoff should be rejected only for engine failure or other catastrophic failure.

Second, my personal study of every DC-10 accident that led to the complete loss or write-off of the airframe (there have been 25) has taught me that most DC-10 accidents have occurred in the takeoff/landing phase of flight and were a result of circumstances that had nothing to do with engine thrust, engine fire, thrust reversers or smoke in the cockpit. The majority of those, most of which were takeoff accidents, were caused by the pilot in command choosing to abort the takeoff (1) for poor reasons or (2) after V_1. The general conclusion of this study backs up the Boeing article in every way.

My third reason is our Dash-1 guidance provides more technique than procedure. Considering the dangers of a rejected takeoff, we need to do a better job training our current and next generation about what to "look for" and "look at," since our pubs don't give them any true direction. Telling someone to abort for a serious emergency is much different from telling them *what a serious emergency is* and *what to look at* to make that decision.

Go/No-Go

Here's my best philosophy on the go/no-go decision: Up to 100 knots, I will be fairly liberal in my abort policy. I will abort for anything out of the normal that justifies staying on the ground and fixing.

After 100 knots and up to V_1: Remember, the Dash-1 says the takeoff is aborted before V_1 if a serious emergency/loss of thrust occurs. To me, these four things justify that argument:

Illustration by Dan Harman

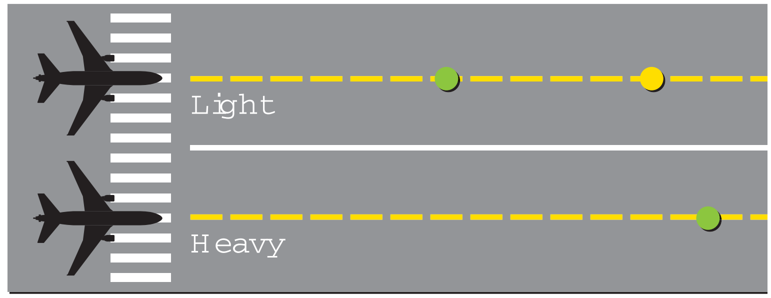


Chart 1

(1) any engine failure
(2) any engine fire
(3) any thrust reverser light
(4) smoke in the cockpit.

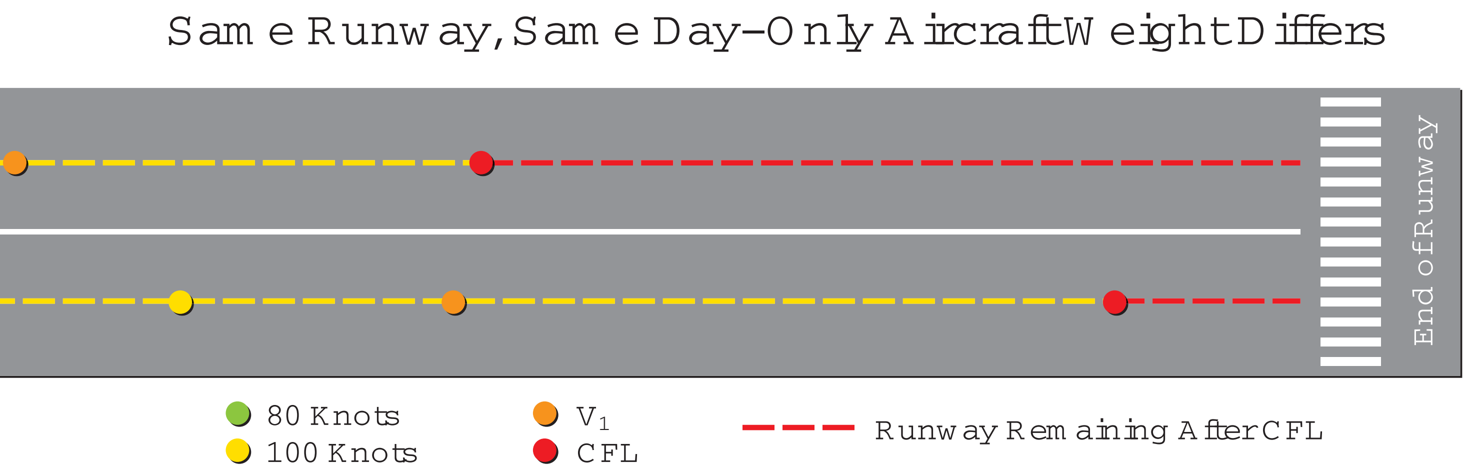
For everything else I will make my decision with the heavy emphasis on continuing the takeoff.

I will not abort for any master warning or master caution lights after 100 knots. There is not much else that I feel I can't take into the air and address safely up there. What would you do for a "low oil pressure" master caution or "cabin cargo smoke" light? What about an "anti-skid" light or "flap/slat disagree" light?

Speaking of an engine failure, what do you use to determine an engine failure? My personal technique is to use the N1 power setting for the "80 knots/power-set" call and then transition exclusively to my EGT and N2 gauges for how my engines are performing up to my V_1 decision/speed. I believe that my EGT and N2 gauges give the most accurate picture of my actual engine performance. Generally speaking, most crew-diagnosed engine failures weren't engine failures at all, but blown tires (the Boeing article goes into this issue). What have you been taught? Remember, the KC-10 Dash-1 says nothing about what to look for, it just says the takeoff is aborted before V_1 if a serious emergency/loss of thrust occurs.

Let's discuss this for (1) a light airplane and (2) a heavy airplane. In this discussion, we are going to stipulate that both aircraft will be taking off on the same length of runway, under the same atmospheric conditions, with the only difference between our two aircraft being the weight.

(1) A light jet has a comparatively lower V_1 (see Chart 1 and Figure 1) and shorter CFL (Critical Field Length). My 100-knot decision to abort for only (1) any engine failure, (2) any engine fire, (3) any thrust reverser light, or (4) smoke in the cockpit still stands true, and because of my comparatively light weight, I also know that my 100-knot decision is closer to my V_1 speed. Another way to think of this is, a



lighter airplane will accelerate quicker and stop quicker, so it will use comparatively less runway, hence the shorter CFL. It makes sense that there will be a small spread between 100 knots and V_1. Since this aircraft is comparatively lighter it will need less runway to stop. In the back of my mind I know 100 knots and V_1 are very close together so I think of a 100-knot abort as basically a V_1 abort because the spread between 100 knots and V_1 is so small. I'm more comfortable with my 100-knot decision being closer to V_1 because the comparative CFL lets me know I have some breathing room.

(2) A heavy jet has a comparatively higher V_1 and longer CFL; therefore, my 100-knot decision is farther away from V_1 (see Chart 1 and Figure 1). Another way to think of this is a heavier airplane accelerates slower on average and takes longer to stop, thereby using up more of your runway available. A heavier jet is also more likely to go off the runway for various reasons: (1) longer CFL, (2) pilot procedure/technique, (3) blown tires, (4) brake failure(s). For a heavy jet, the spread between 100 knots and V_1 is greater, and the decision to abort after 100 knots is more critical because you are quickly using up that runway available to accelerate and, if needed, abort. In my mind, the faster I get, the longer I'll need to stop. So at 100 knots, I consider myself in the high-speed takeoff regime. I'll absolutely abort for my four conditions: (1) any engine failure, (2) any engine fire, (3) any thrust reverser light, or (4) smoke in the cockpit. However, I'll place heavy emphasis on continuing for almost everything else.

Why 100 Knots?

For one, the Boeing article makes a strong argument in favor of a 100-knot decision as entry into the high-speed takeoff regime. I consider Boeing to be the world big airplane experts; so if it's good enough for them, I'll listen to what they say. In addition, 100 knots for me is an easy, safe and effective way to implement my Dash-1 guidance in the gray area of "as you approach V_1." One hundred knots makes sense for a light aircraft as well as a heavy aircraft. Additionally, the overwhelming number of accident/incident statistics and reports support the "go" decision above that speed. If you're able to devise your own sound system based on aircraft weight/conditions, more power to you.

What about the loss-of-all-electrical emergency?

Everyone brings this up in the KC-10 community. First off, I've never heard of a KC-10 having a loss-of-all-electrical emergency. I have heard some shop talk that the *D*C-10 had a loss-of-all-electrical issue during its FAA certification phase, caused by all three throttles rolling back to ground idle during flight and kicking off all the aircraft generators. This is only one of the reasons why we now have a flight idle setting. So what I'm getting at is the chances of this emergency are very rare, but yes, still possible. Let's review the facts of this emergency.

You are at V_1 (or very close to it) and have the loss-of-all-electrical emergency. If you continue, you will likely lose the number 2 engine for the remainder of the takeoff, but you still have up to go-around power or even mechanical limits on the remaining throttles, if needed. If you abort (see Loss-of-All-Electrical-Power/Loss-of-All-Generators-Portion of checklist) you will not have any (a) anti-skid or (b) thrust reversers until the flight engineer (FE) restores some power, and (c) the spoilers will not automatically deploy. So the FE (or you) needs to deploy the spoilers after completing your Boldface, and you'll be using up valuable runway the entire time you're trying to accomplish this. You have to ask yourself, if you're heavy and critical field length (CFL) is fairly close to runway available, are you going to stop in that computed CFL with potentially no anti-skid, possible blown tires, no thrust reversers, and late or no spoilers? There is no easy answer to this question.

Let's first ponder the idea of no anti-skid braking. The Dash-1 says that CFL stopping distance is accomplished using full anti-skid braking (1-1, pg. 12-8). You have to ask yourself, "How much distance will be added to my stopping distance for late/no anti-skid braking?" There is no easy way to find this answer. You can start by looking at the Correction Factor For Configuration Changes (CFCC) Chart (1-1, fig. 3-8), which does include a correction for no anti-skid. However, the problem with the CFCC chart is it is used *before* you take off and, compared to otherwise normal numbers for your jet, gives you a reduced maximum takeoff gross weight, lower V_1 and longer CFL. This does you little good rolling down the runway when you are *above* what that new CFCC-computed lower maximum takeoff gross weight or V_1 would have been. You are in a gray area. You may also look at the Equivalent RCR Chart (1-1, fig. 9-13) for Anti-Skid Braking Inoperative. Although this chart is listed in the landing section of your 1-1 (and I know I'm talking about takeoff scenarios, but this is worth mentioning) it will lead you to the fact that your *ground roll* stopping distance is increased roughly 2.5 times for a dry runway landing with anti-skid braking inoperative. If that's not shocking enough, for a wet runway landing with anti-skid braking inoperative your ground roll stopping distance increases an amazing 4.0 times. Once again, this chart doesn't give you hard and fast numbers that you can use for this takeoff scenario; it's all a gray area.

How about thrust reversers? Thrust reversers *are used* to calculate your CFL under normal everyday circumstances (1-1, pg. 3-10), and being unable to use them will increase your stopping distance. Although they aren't as important as anti-skid braking when it comes to stopping the KC-10, the lack of them does increase your CFL, or stopping distance. The question again is, "How much?" And again there is no easy way to find this answer. There are charts in the supplemental performance section of your 1-1 that do have corrections for no reverse thrust (start at 1-1, fig. 12-32/35). However, as mentioned above, these charts are used *before* you take off, and compared to otherwise normal numbers for your jet, give you a reduced maximum takeoff gross weight, lower V_1 and longer CFL. In most cases the resultant performance loss will be minor, but there is always a performance loss. This does you little good rolling down the runway when you are *above* what that new "no reverse thrust" computed lower maximum takeoff gross weight or V_1 would have been. Sorry, you're in a gray area again.

Spoilers? There is no Dash-1 correction for inoperative spoilers on takeoff, so you can think of your spoilers as a "bonus" stopping device in the event of an aborted takeoff. Keep in mind there is an Auto Spoiler Do Not Use Lt On/Auto Spoilers Inop Checklist that is used to recompute your landing distance. But that checklist is concerned with landing only, and here we are concerned with the aborted takeoff. Although you can think of spoilers as a stopping distance "bonus" in this takeoff scenario, you still have no idea just how much they are going to help you. Also, as mentioned before, they won't automatically deploy, so until you or the engineer complete your Boldface and remember to deploy them, they aren't going to help you very much.

Of course, you can "what if" this scenario to death. After completing your Boldface, you might get power back in just 2-3 seconds and have everything you need to stop safely. Maybe it'll happen at a speed significantly lower than V_1 and won't be an issue. You name it, in this situation it's all a gray area and generates much discussion. Tough call, but if CFL is close to runway available, then I think I'm going.

What about doing touch-and-goes?

Touch-and-go landing procedures are no different from normal landing procedures up to the point of touchdown. After that the decision to continue or abort a touch-and-go is fairly similar to a normal takeoff.

Upon touchdown you will typically call for a re-configuration of the jet, which in the KC-10 is "FLAPS 22 AND CHECK TRIM IN THE GREEN." If anything abnormal happens that would justify making this landing a full stop instead of a touch-and-go, this is the place where I'll easily and safely abort the touch-and-go. *This phase is similar to my normal takeoff from the start of the takeoff roll to 100 knots.*

After the above re-configuration the pilot not flying (PNF) will call "PUSH THEM UP" and the pilot flying (PF) will advance the throttles to approximately the 12 o'clock position. After the "PUSH THEM UP" call is made and the throttles have advanced forward I will only abort for (1) any engine failure, (2) any engine fire, (3) any thrust reverser light, or (4) smoke in the cockpit. *This is similar to my normal takeoff between 100 knots and V_1.*

After doing a quick scan of the engines, the pilot in command (PIC) will then call for "SET T/O POWER." Then the final touch-and-go power setting will be set. After this call, I am committed. *This is similar to my normal takeoff call of V_1.*

The Golden Rule—Know how long your ground roll stopping distance is and that means knowing your weight and runway condition.

Let's run an example for a logic check and review a couple of gotcha's. Let's use some conservative averages. You are doing a touch-and-go on a 10,000-foot runway, with a normal 35 flap configuration, sea level, 20 degrees Celsius, and you're on speed. You touch down 3000 feet down the runway (our normal go-around point if not touched down) and use up approximately 1500 feet re-configuring your

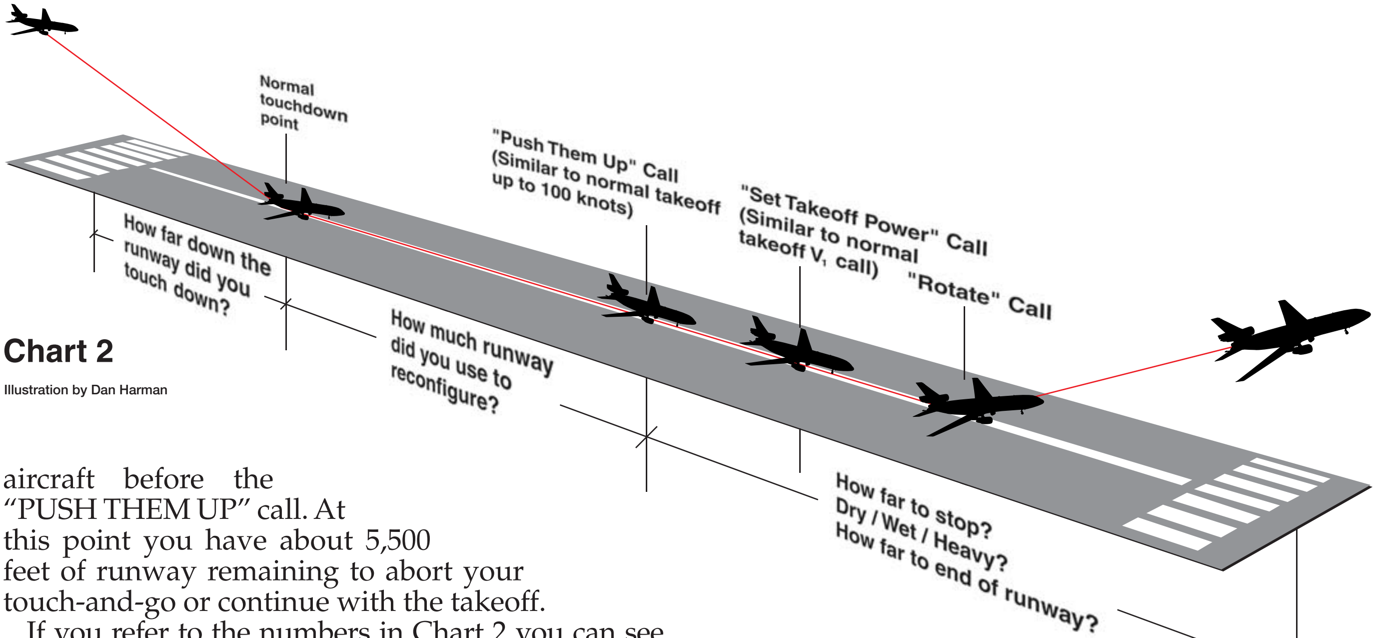


Chart 2

Illustration by Dan Harman

aircraft before the "PUSH THEM UP" call. At this point you have about 5,500 feet of runway remaining to abort your touch-and-go or continue with the takeoff.

If you refer to the numbers in Chart 2 you can see that for a dry runway ground roll you will need roughly 2921 feet of runway (for a KC-10 maximum landing weight of 436K pounds) to stop the jet. Round that up a little for mom and the kids, and you should be able to abort that takeoff up to the "SET T/O POWER" call; no problem. Nothing surprising there; long, dry runways are good things.

Now, let's say you're doing a touch-and-go on a shorter runway, such as McGuire AFB's 7124-foot runway. Here it's best to go to the chart and pick some gross weight/landing ground roll numbers of your own. You can see that after you subtract how far down the runway you touch down and how much runway you consume re-configuring, you might not have a lot of cushion left to abort. One highly recommended technique on short runways is do not float the landing and go around if you do. My personal limit has been main gear on the ground within the first 2000 feet. In addition, consider using your "PUSH THEM UP" call as your go/no-go decision instead of "SET TAKEOFF POWER." Touch-and-goes can be completed safely on the shorter runways, and can be real confidence boosters. You just need to know the Golden Rule and understand how you are using up your runway.

What if your 10,000-foot runway is wet? Now your ground roll stopping distance is basically twice as long as on a dry runway (1.98 times to be exact; see Chart 2). Let's say in this example your jet weighs 400K and you are indeed on a wet runway. The chart says you will need roughly 5284 feet of runway in front of you to stop the jet. If you round that up a little for mom and the kids, that 5500 feet of runway available might not be enough to abort your touch-and-go at the 'SET T/O POWER' call if: (1) you landed 3000+ feet down (2) you used up a lot of runway reconfiguring. The same techniques work on wet runways also. Know the golden rule (i.e., are you too heavy) and have the discipline to send yourself around if you float the landing. You can also consider using your "PUSH THEM UP" call as your go/no-go decision instead of "SET T/O POWER."

A quick word about energy. In Chart 2 I also listed some generic normal takeoff V_1 speeds for dry/wet runway conditions. If you compare those normal takeoff V_1 speeds to what your approach speed is for that given weight, you will see that even if you decrease to approach speed -15 knots during your touch-and-go (very unlikely from my experience) you will still be considerably faster than what your V_1 would have been for a normal takeoff. That's just some food for thought, and that's one of the reasons why I'm more go-oriented during my touch-and-goes, especially on short *or* wet runways. I *don't* do touch-and-goes on short *and* wet runways.

In all situations, the Golden Rule is to recognize how long your ground roll stopping distance is. Never abort if your ground roll stopping distance is longer than the runway remaining without accepting the fact that you'll probably have difficulty stopping within the confines of the runway.

The decision to continue or abort a takeoff or touch-and-go can be a complicated issue, but you can make it easier and safer on yourself with study, training and experience. Talk with your fellow pilots and IPs; they should have the experience and knowledge to get you thinking about the important issues. There are few hard and fast rules. My techniques are just that, my techniques, so every pilot needs to develop his or her own, and keep in mind that as the AC you are ultimately responsible for making your own go/no-go decision. It could prove to be one of the toughest things you ever do. ✈

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

USAF Photos

FAST!

Using High Technology to Help Solve the FOD Problem

GEORGE MORSE
Failure Analysis Service Technology, Inc.

An engine is damaged by FOD, but what actually did the damage? The damage to the engine shown in Figure 1 is quite significant. Is there a way to prevent this sort of damage from occurring again? There may be, but first it is necessary to determine exactly what happened. This is where FAST comes in. FAST is an acronym for Failure Analysis Service Technology, Inc. The company has perfected a non-destructive method for determining the source of impact damage to airframes and engines. The FAST FOD procedure is based on the fact that when an object impacts a jet engine blade, inlet duct area, the horizontal stabilizer, or any part of the aircraft with sufficient force to damage the aircraft, the impacting object will leave a little bit of itself in the damaged area. The material left behind in the damaged area is usually not visible to the naked eye. Replicas, called FAST samples, are taken from the impact areas using a special tape, which is used to remove these particles of foreign debris. The FAST samples are then viewed under magnification and identified. FAST samples provide a permanent record of both the impact site and impacting debris. FAST also evaluates the geometric characteristics of the physical damage in conjunction with the forensic evidence to aid in determining the physical properties of the impacting object as well as the point of entry of the object.

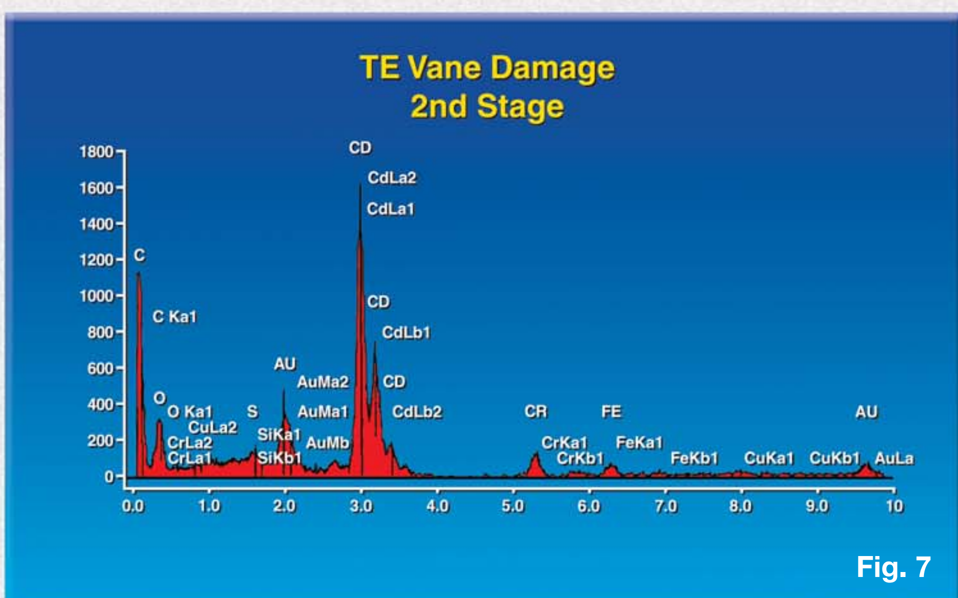


Fig. 7

The FAST process assumes that the impacting material can be uniquely identified. This generally is the case, because engine materials are different from airframe materials, and airframe materials are different from non-aircraft materials. FAST exploits the materials chemical "fingerprint" by analyzing the microscopic particles. This process is similar to DNA pattern recognition used by forensic scientists in criminal investigations. Having successfully investigated over 1700 engine mishaps using this procedure, FAST is currently examining approximately 50 mishaps per year for the United States Air Force.

The entire process is a team effort between FAST and the aircraft operator. The process is initiated when the aircraft operator takes photos of the damage as well as the FAST samples. FAST provides guidelines on how to do this. The photos and samples are then sent to FAST for intensive analysis.

An actual example may better illustrate the process. Compressor damage was discovered following an engine run for a prop valve housing change on a T56 engine. There is leading edge (LE) 1st stage vane damage with impact to the concave surface, Figure 2. The impact resulted in curling the vane in the direction of engine rotation. This damage characteristic indicates that the impacting object entered from in front of the vane, and was in fact thrown into the vane by a rotating 1st stage blade, which is just forward of the vane. Close-up views of engine damage reveal multiple damage geometries. There is a circular shaped dent with secondary indention in the overall circular impact, Figure 3. The secondary indentations reveal a radial pattern. Another impact shows the radial pattern emanating from the center of a small circular impression, Figure 4. These impacts are consistent with impact by the end of a castellated nut.

A castellated nut cannot account for either the narrow diameter cylindrical-shaped impacts shown in Figure 5, or the smaller safety wire size circular shaped dents on several vane impacts, Figure 6. This damage is consistent with impact by the end of a cotter pin or safety wire.

The FAST samples provided conclusive evidence as to the source of the impacting components. Notice the lightened areas in Figures 4 and 6. FAST samples were taken from these impact sites. The sampling clearly removed particulate matter including dirt. Cadmium-plated steel with a chromate conversion coating was found as foreign debris on both types of impact damage discussed above, Figures 7 and 8. This material combination is used for propeller after-body hardware including valve body housing hardware. Both the nut and cotter pin shown in the title are made of this material. In this particular case, we were able to differentiate between a cotter pin and safety wire, since aircraft safety wire is not made of cadmium-plated steel.

Replicas, are taken from the impact areas using a special tape.

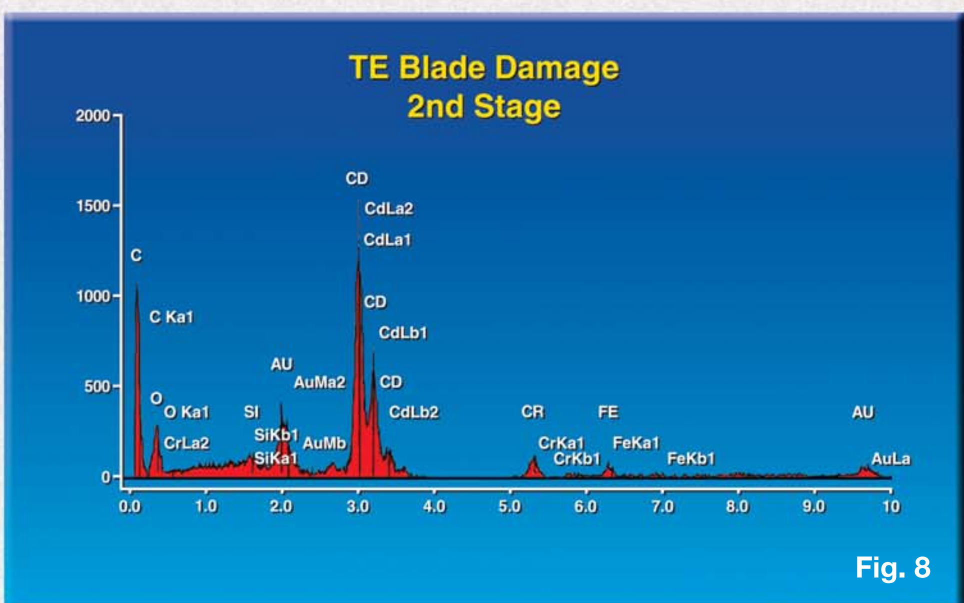


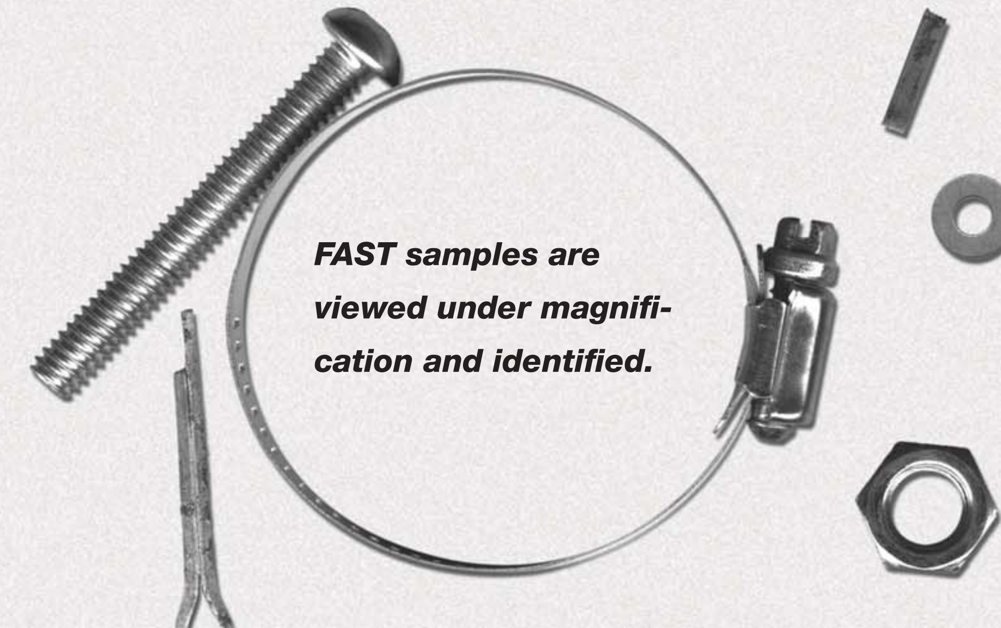
Fig. 8

FAST reported to the plane's user organization that both the physical damage and the forensic evidence were consistent with impact by two objects: one a castellated nut, and the other a cotter pin. Both objects are made of cadmium-plated steel with a chromate conversion coating applied over the cadmium. This gives the materials a gold iridescent appearance. Both objects are highly attractive to a magnet. The diameter of the castellated nut is the same diameter as the larger circular-shaped impacts. This information was sufficient for the user to identify the components. In some cases, the user unit will send components that match the material and physical description for analysis and positive ID.

In itself, the FAST process does not lead to FOD prevention. The *user* must take appropriate actions to prevent recurrence. However, the FAST process greatly aids in determining where the focus of prevention should be. Here are a few examples:

- After removal and replacement of anti-skid material from aircraft carrier decks, aircraft were ingesting steel balls used to remove the anti-skid. The steel balls were buried within the new anti-skid providing a site for the anti-skid to break apart. Aircraft ingested both the anti-skid and the steel balls. (FAST recommended the use of ice pellets or frozen carbon dioxide pellets instead of steel balls.)
- Stainless steel balls were eliminated from cleaning rubber build-up at the approach ends of the runways at a major U.S. commercial airport based on FAST's work. (FAST recommended the use of a commercially available and EPA-approved chemical treatment for removal of the rubber build-up.)
- A migration pattern for broken fasteners was identified in the wing–slat area of the A-10 aircraft. (Four occurrences per year were identified with this problem prior to the FAST investigation.)
- Numerous areas of concrete FOD potential were identified based on FAST's work. (FAST was able to specifically identify the location of the pavement problem.)
- A change in the operational procedures in the use of some APUs during deicing and wintertime operations were made based on FAST's work. The changes eliminated that specific ice FOD problem.
- FAST identified the radar liquid cooling door on the F-18 as a source of FOD for that aircraft. This was previously not considered as a possibility.
- FAST identified a hinge problem on the F-117 as a source of FOD.

Through teamwork with FAST as a major player, significant FOD reduction can be achieved. If you would like more information on this technology or how to use it, please call FAST at 1-800-657-5664.



FAST samples are viewed under magnification and identified.

The Giant Hand

USAF Photos
Photo Illustration by Dan Harman

MAJ JEFF WICKSTROM
USAFR

Over the years, I've been to a lot of physiological training: Laughlin, Williams, Wiesbaden, Alconbury, Holloman, Reese, Sheppard. Amazing how many of those places are no longer around. Although the presentation changed over time, the nuts and bolts were pretty much the same each visit—illusions, hypoxia, inner ear stuff, and my personal favorite, flicker vertigo. Sure, valuable information, but not the kind of things that had ever bothered me.

In fact, the only event I could ever recall that even came close to a physiological incident was flying the OA-37 at Davis-Monthan. Clear, sunny Arizona, not exactly the place you'd expect to have a problem. However, this day was one of those milk-bowl, hazy days, a couple miles of visibility but completely white, above, below and no horizon. For some reason, the flight lead called for an echelon turn while we were turning to instrument downwind and an eventual formation landing. We rolled into a 60-70 degree bank. I was right in there but the turn seemed to go on forever. Finally, the flight lead came across the radio and said, "Two, where are you?" I answered, "I'm right here in echelon!" His response: "Two, we rolled out fifteen seconds ago." Sure enough, we had rolled out, we were in straight and level flight and I'd stayed right in position, but now, rather than being in echelon, I was directly beneath my flight lead and looking up at him. My seat-of-the-pants instincts told me we were still in the turn. It took a little mental convincing to get back in proper position. An amusing, innocent situation, and that was the worst I'd ever experienced. That all changed on a dark night in Alaska.

It had actually warmed up—only 45 below.

In January 1997, after flying A-10s in the Reserves, I was on a two-year leave of absence from my airline job and back on active duty at Eielson AFB, Alaska. I had been at Eielson a week. I'd been issued all my Arctic flying gear, I'd done my quickie one-day Arctic survival course, had my initial local area orientation sortie and now our A-10 squadron was about to deploy to Aviano, Italy, to fly missions over Bosnia. Quick transitions were nothing new, but here in Alaska there was a whole new set of variables that altered my comfort level. The near constant darkness and the three layers of insulated clothes necessary to fly in the extreme sub-zero temperatures were two of the big issues that made it hit home that this place was a whole different world.

We were launching out at 0200 so that we could make the east coast and land in daylight. The previous night we had canceled the launch because the temperature had been 50 below. This night we'd received a waiver, so we were going, and it had actually warmed up—only 45 below. The flight surgeon told us that if we ejected our eyeballs would freeze before we hit the ground. I never was certain whether he was joking or not.

Am I over the Canadian Rockies? If I am, how high do they go?

I was one of two airborne spares. The plan was that after the primary six jets met up with and had successfully taken on fuel from the tanker, the air spares would return to Eielson. However, if one of the primaries had any difficulties that wouldn't allow them to take off or required a return to base, an air spare would replace them and continue on to the east coast and eventually Aviano. So even though I expected to return to Eielson, I had to load up my jet and travel pod with the things I'd need in Italy over the next two months.

Loading up the travel pod was simple enough. Setting up my cockpit was a different story. NVGs (something I was still new to), box lunch, extra approach books and maps, hand-held GPS, my day visor, things to occupy the time on the ten-hour flight, and the three layers of clothes I was wearing made for a cramped cockpit. A new experience in the normally roomy A-10.

Finally the six primary and two air spares taxied out of our heated shelters. With two external fuel tanks on each jet, we took off in turn. We eventually leveled off at Flight Level 210 with no moon, no stars, no horizon. And in Alaska, even if we could have seen the ground, there was almost no cultural lighting. Now, 300 miles east of Eielson, over the Canadian Yukon and completely out of range of any air traffic control communications, the six primary jets were joining with the tanker. Soon, my element lead and I were expecting to turn back towards base.

About that time, on the right side, in a loose route position, I noticed I was a bit closer to my lead than I wanted to be. I made a gentle, slight bank away to the left. I glanced back at my lead and was puzzled to see that he was descending. Since it was total darkness, the only reference I had that he was indeed descending was that his position lights were going lower, below my canopy rail. Rather quickly, I had to lean over and look well below the rail to see my lead.

Still baffled that he would descend, I looked inside at my instruments. What I saw only added to the confusion. I was in a sixty-degree bank to the right, thirty degrees nose low and my altitude was winding down. My element leading hadn't been descending, my bank had been increasing. Well, that could easily be corrected with a few inputs back to the left. However, in spite of the almost subconscious commands to roll out and level off, it didn't happen. I scanned my instruments again. Still in a spiraling descent into the blackness below, I saw my problem. Left engine ITT was spiked and RPM rolled back, a compressor stall or worse.

I made the radio call, "Number 8's got an engine failure."

I tried to roll out but it just wasn't happening. Of course, the two external fuel tanks weren't helping, but my inputs still should have been enough.

Some quick thoughts went through my head. "That Giant Hand thing; you think you're making the necessary inputs but there's some mental block that won't let it happen." I had to focus my concentration on my flight instruments. Roll out, pull up to level flight! Going through 17,000 feet I started wondering where I was over Canada. "Am I over the Canadian Rockies? If I am, how high do they go? Was our flight surgeon joking about eyeballs freezing?" I was shocked at the effort and the time required to level off.

Finally, at 15,000, I stopped the descent, but within seconds of accomplishing that I got a fire light in the left engine.

I called, "Number 8's got a fire light now!"

The flight lead answered, "Hope it's the same engine."

The fire light and the actions to put it out took my attention away from my flight instruments and I lost another 1000 feet.

I had lost 7000 feet, but at 14,000 feet I finally turned west back towards Eielson. I toggled back the INS to the ramp coordinates. I knew there was no way I was going to be able to read a checklist. All my attention was required just to stay in level flight. In spite of turning on the operable yaw SAS and a complete deflection of rudder trim, I still needed significant rudder input to stay straight and level. I started the APU and opened the fuel crossfeed. About that time my element lead, the other air spare, told me he had put on his NVGs and was chasing me down. My jet was pretty easy to see since looking back to the west I was the only object emitting any light.

Knowing that I had to jettison my external tanks before I could land single-engine, I debated getting rid of them right away. However, with the feeling that problems seemed to be compounding (I had just noticed the lights on my ILS and TACAN control panels were burnt out), I decided to keep them until I was closer to Eielson. The way my luck was running that night, I could just see jettisoning the tanks and have one hang up. Plus, I didn't want to emergency jettison and totally clean off the wings. Being new to the squadron, I couldn't remember if the travel pod would come off, too. Since I had a new CD player in the travel pod, I certainly didn't want to lose that.

As the element lead caught up, he misjudged his closure and shot right over the top of my jet. My quick head movement up to see him pass over the top caused an unexpected tumbling sensation. The element lead said he was having the same problem, extreme vertigo, brought on by his quick deceleration on NVGs and his rapid head movement to keep me in sight. Great; two jets in close proximity and both guys' heads tumbling out of control. My vertigo was intense. The feeling of falling head-over-heels was powerful. Looking at the attitude indicator didn't seem to help. Glancing up at the HUD and looking at the level flight indicator did the trick.

Once that episode was over and the element lead was back in a safe chase, the major difficulties were behind us. All that remained was 250 miles back to Eielson. Finally, we were able to talk with Anchorage Center and eventually A-10 operations. Appropriate checklists were read. The external tanks were dropped in our jettison area. They were found a couple of weeks later by a local trapper out checking his line with his sled and dog team. I followed the element lead down the ILS and landed just before 0500. It was still 45 below and the sun wouldn't peek above the horizon for almost six hours.

From virtually no experience to almost everything in one night. Light illusions, Giant Hand, near incapacitating tumbling sensations. All that physiological training had indeed paid off. I knew what I was experiencing and how to overcome the problems. However, there was one disappointing aspect to that dark Alaska night—no flicker vertigo, my personal favorite.

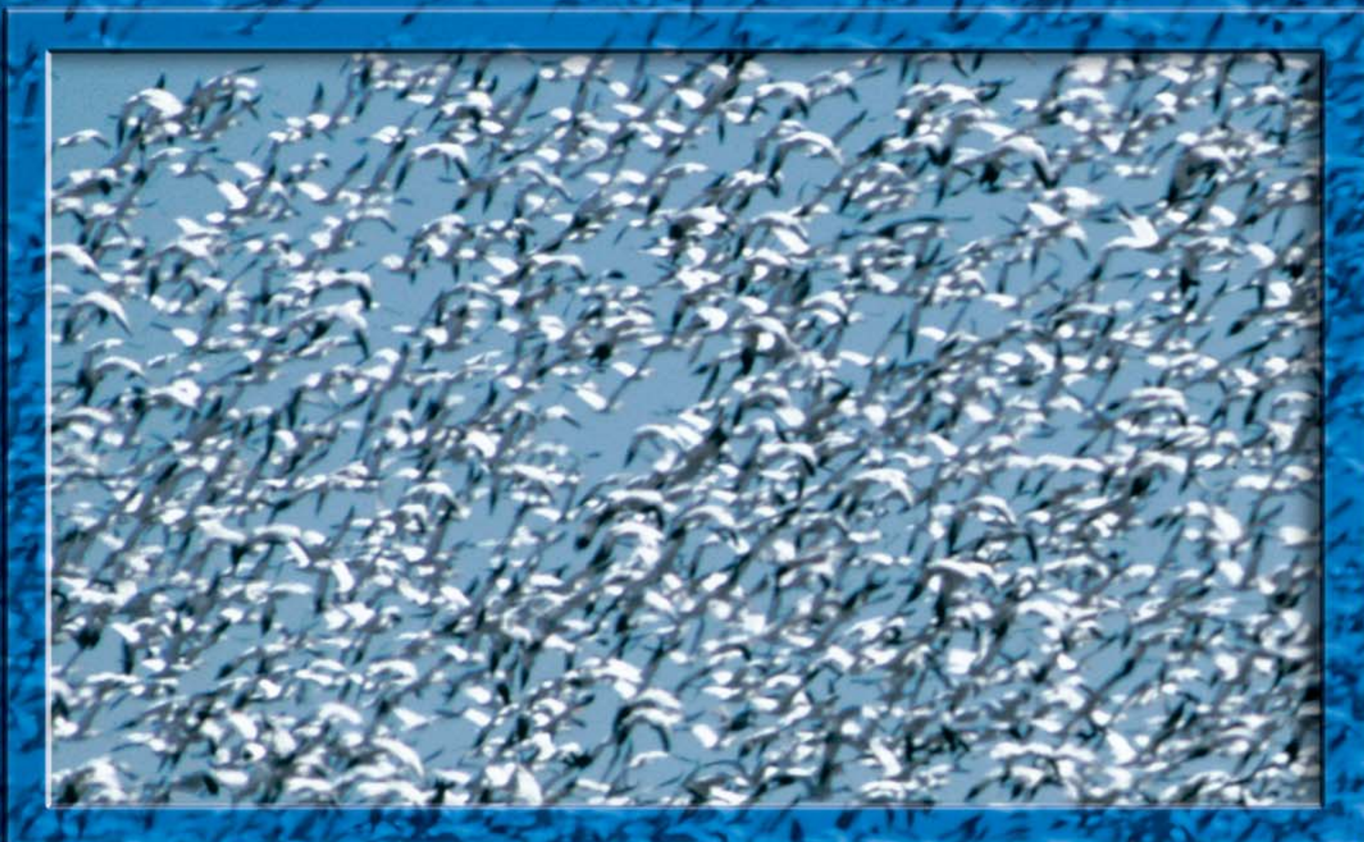
My quick head movement caused an unexpected tumbling sensation.

Lt Col Gregory E. Davis, Flight Commander, Aerospace Physiology at Sheppard AFB TX, comments:

"Maj Wickstrom related his story to me when he came to Sheppard in the summer of 2002 for a refresher course in Aerospace Physiology. I noted besides the Giant Hand effect, he also had a graveyard spiral going. This is the first episode I've heard of somebody surviving in recent years. Our last similar incident produced a Class A mishap with a fatality. Spatial D, as we call it, can be deadly and it is up to us, the pilots, to pay attention and put ourselves through the learning in Aerospace Physiology.

"Currently, the Air Force has one ASDT (Advanced Spatial Disorientation Trainer) at Randolph AFB. The pilots who go through the PIT Instructor pipeline get to go through this training, as do the pilots who go through the AIS (Advanced Instrument School). It's well worth the trip, if you can arrange it, to get your refresher training done there and see if they have the ASDT available for you to take a spin. Brief 'em up and fly safe!"

You Might Have A BASH Problem If…



HQ AFSC Photo by TSgt Michael Featherston
Photo Illustration by Dan Harman

"CAPT GRAZ MARLA"
HQ AFSC/SEFW

As a captain in the world's greatest air and space force, I've heard a few observations about bird/wildlife aircraft strike hazards (BASH) that have struck me as odd or amusing. From the Rambo imitators wanting to patrol the airfield strapped with a semi-automatic raining death on the feathered foes, to those who want to establish wildlife preserves adjacent to the main runway, there has been a wide spectrum of views on this unique topic. I've never been accused of being a genius, but I do know that it's not smart to have lots of animals roaming around your airfield. If you're not sure if you have a BASH problem, I've devised a little "matrix" or test (of sorts) to help you.

…You have more birds than planes taking off on your runway.
…You have more ammo than Bruce Willis in a "Die Hard" film.
…Birds suddenly appear every time you are near (or just like me, they may long to be close to you).
…You sing bird distress calls in the shower.
…You considered naming your child AHAS or BAM.
…You've called the USAF BASH Team more times than you've called your spouse in the past 12 months.
…You've considered the annual BASH issue of *Flying Safety Magazine* to have Pulitzer Prize-caliber articles.
…You've made it your life's mission to hit every bird you see on the highway with your car.
…You have more geese than retirees on your golf course.
…The Red-Tailed Hawks put on a better airshow at your airfield than your aircraft.
…You have locals trying to sneak on your airfield at night to hunt ducks.
…You've ever said, "Look how fast that deer moves across the runway."
…The propane cannons on your airfields begin to sound melodic.
…Your depredation permit is framed on the wall next to your high school diploma.
…You think "depredate" means taking your sister out for a romantic dinner.
…Near-runway, off-base property prices are on the rise with advertisements promoting "Beautiful Views of Wildlife."
…A crew chief has nicknamed their plane "Bird Killer," "Feather FOD-er," or "Vulture Chaser."
…You "dream about glorious hip shots and ducks on the wing," and you're not quoting the movie "A Christmas Story."
…You can say the words "plumulateous barbules" and be carrying on a normal conversation at the same time, you DEFINITELY have a BASH problem!
…Your BASH Plan could qualify you for a Ph. D. in ornithology.
…The local birding club designates your runway as its top bird watching site.
…Your Friday afternoon ritual includes regaling others about your near-misses with wildlife.
…Your pilots regularly refer to birds on the airfield as "them bogies."
…You fondly refer to your depredation shotgun as "Old Faithful."
…The locals refer to your base as Sesame Street because you have big birds.
…You refer to your depredation unit as "the Mod squad."
…You feel like an extra in Hitchcock's "The Birds."
…Your depredation efforts remind people of the "Texas Chainsaw Massacre."
…The death of Bambi's mother brings you vindication.
…The BASH Team is number one on your speed dial.
…You know what the terms "murder," "parliament," and "gaggle" mean in biology-speak.

And finally…
If you're offended by any of these because you can personally identify with them, you may have a BASH problem.

Well, I've got to get back to doing those things that we captains do. If you're ever at Kirtland AFB, be sure to stop by the AF Safety Center and visit with those bird folks on the BASH Team. This quality group of USAF warriors are always willing to lend whatever assistance they can. Please take care of yourselves and each other.

Good CRM Can

USAF Photos — Photo Illustration by Dan Harman

MAJOR JEFF PIERCE
97 AMW/SE
Altus AFB OK

A little over a year ago, before PCSing to the "Mobility Training Mecca" in Altus America, I experienced a situation that drove home the need for good Crew Resource Management (CRM). I use this example as I discuss CRM with students here at the C-17 schoolhouse and believe it is a good example of how possible catastrophes can be avoided when crewmembers use CRM to work together.

My experience happened on a routine C-17 cargo delivery mission from Richmond, Australia, to Hickam AFB, Hawaii. The situation occurred on the second leg of the flight from Australia to Hickam. My crew had been to Australia for an air show, so we had a large crew consisting of four loadmasters and five pilots, including me as the overall aircraft commander. The aircraft was loaded and our first leg was uneventful. Our next departure and climb to a cruising altitude of FL310 enroute to Hickam AFB were equally uneventful.

Before I go any further, I should briefly describe our load as it had a unique characteristic that proved very fortunate for us later. There were 20 space-available passengers and seven pallets of cargo with a total weight of about 50,000 pounds. The pallets were lined up down the center of the aircraft using the Aerial Delivery System (ADS) cargo rails and locks. The unique part was that one pallet contained metal pieces that hung beyond the pallet edge, requiring space between pallets to accommodate the overhang. The senior loadmaster made the outstanding decision to place cargo restraint chains on the overhang portions—though not required—to provide extra stability in addition to the required ADS rail locks. The remaining pallets were positioned with four in front of the overhang pallet and two behind.

Back to the flight. After an hour and a half at cruise altitude, I went to the crew bunk to get a couple of hours rest. The operating crew consisted of a copilot in the left pilot seat, an instructor aircraft commander in the right pilot seat and the senior loadmaster—a Master Sergeant—in the loadmaster seat with another loadmaster—a Senior Airman—assisting him. The remaining crewmembers were resting, as this flight was through the night and people were getting tired.

About 30 minutes after I went to the bunk, the Master Sergeant loadmaster swapped out with the Senior Airman loadmaster to do a cargo check and use the latrine. The right seat pilot got out of the seat to use the galley, briefly leaving only the copilot and the Senior Airman loadmaster on headset. Now is when the CRM situation gets interesting.

The Senior Airman loadmaster decided that the ADS rail locks located in the empty space between a couple of the pallets—remember the overhang—should be engaged to provide an extra margin of safety, so he requested loadmaster panel power from the copilot. This action would allow him to control the cargo and door systems in the back of the aircraft. Lock engagement in the empty space was not actually necessary, nor would it provide an extra margin of safety, but no discussion of the matter took place with more experienced crewmembers. The copilot, knowing that arming panel power in flight for a non-airdrop mission was unusual, asked the loadmaster if he was sure of his request. The two of them then agreed, after a short discussion between themselves, that arming the panel was a good idea, and the loadmaster assured the copilot that only ADS rail locks in the empty space would be activated. Once given panel power, the loadmaster mistakenly selected all ADS rail locks and then released them, rendering the entire cargo load unrestrained.

The aircraft deck angle was such that the cargo shifted aft, causing the aircraft to begin to pitch up. The resulting change in center of gravity forced the autopilot to kick off, as it could not keep up with the sudden change. Then BANG! The forward four pallets rolled about a foot before slamming into the pallet with overhang while the aft two pallets rolled to the ramp. Fortunately, the restraint chains placed on the overhang pallet stopped most of the cargo from moving too far aft. This kept the center of gravity within acceptable limits and allowed the copilot to arrest the pitch up and correct to altitude.

Needless to say, the entire crew and passengers were all wide awake following the event. The extra crewmembers assisted in pushing the pallets back to their positions and locking them in place with the ADS rail locks. Then, we all put our headsets on to discuss the event and discover the cause.

I probably do not need to tell you this, but if the restraint chains had not been there to stop the cargo from sliding aft to the tail, it's very likely the aircraft would have stalled from the resultant pitch up. The pitch down that would inevitably follow the stall would send the loose cargo slamming back to the front of the aircraft. Recovery from this event would not have been easy or even probable considering the likely damage sustained from a loose load. As an additional point, if a passenger or crewmember had been between a couple of those pallets, given that we were several hours away from a landing surface and medical attention, the injury could have easily been fatal. The only thing I will say with absolute certainty is we were extremely fortunate to have avoided a catastrophe. Now let's press on to the lessons I learned.

1. If you question something being done, speak up early and loud. If you have doubts about an action being taken by the crew, don't play "I have a secret" or fear ridicule for being wrong. If you are wrong, talking about it might teach you something. If you are correct, you might have saved your life and the lives of everyone else on the aircraft.

2. Don't make isolated decisions. Any time a non-standard action is being planned, take the time to discuss the issue thoroughly prior to taking action. Don't make a decision when most of the crew is not in a position to provide valuable input. Remember, we all have varying experiences and knowledge levels; use all crewmembers fully.

3. Reinforce CRM every time you fly. We briefed CRM before we began the mission as usual. I did not, however, specifically mention CRM on each day before we flew particular legs of the mission. In hindsight, had I done so, the individual in question might have felt more comfortable about bringing his concern up with all the crew instead of attempting to act alone.

4. The aircraft commander is decision authority. Don't forget that the ultimate decision authority and responsibility for actions on the aircraft lie with the aircraft commander. Don't decide on your own to perform non-standard actions that affect the entire aircraft and personnel on board. You can bet I would have liked to participate in those discussions prior to the action being performed.

I don't mean to belittle anyone who was involved in this incident. It is clear that everyone involved had the best intentions with their actions, at the time believing those actions to be correct and safe. Do, however, use this situation as a reminder of how to discuss and correct situations you encounter on future missions. Good CRM can prevent disasters when given the chance. And, as always, continue to fly safe!

Prevent Disaster

Illustration by Dan Harman

The Real Air Hero

CAPT IRA C. EAKER
Army Air Corps
From *US Air Services Magazine*
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The good engine mech knows every part, every symptom, every malfunction.

Every generation of every nationality requires a hero. It finds one or makes one. In earliest times he was mythical; a little later he was some great warrior or explorer. But some man has always been set apart from his fellows and accorded the adulation of the multitude.

A few years after the war (World War I) heroes began to run out; this emotional complex, this crowd psychology, led the people to cast about for some new head to crown. Then, along came the spectacular flights. At this juncture, America was searching its collective soul for a new hero, and it seized upon these unsuspecting fliers. So the toga was handed about, falling in turn upon each succeeding ocean spanner or record breaker.

Strangely enough, with all the shouting that has been done, all the medals which have been struck, the right man in this flying business has yet to be picked.

Human flight was a comparatively new art. For thousands of years, man had longed to soar among the clouds. It was not unnatural, then, that some member of the flying fraternity should fill the national need for a hero. For some reason, the pilot was selected. He it was whose will directed these new machines of flight; whose courage permitted performance of such feats of daring high above the earth. So, selected he was. And each small boy decided not to be a policeman, fireman, or railroad engineer, but envisioned himself a flier when he grew to man's estate.

So we pulled a parade, waved flags, made medals, played the band, and greeted like a Viking arriving at Valhalla each new pilot who flew a little higher, or a little longer, or a little faster. Why not? Your airman wore proudly the symbols of his profession. He was the striking figure in this new industry. Small wonder that the little lads foreswore old models and changed their boyhood dreams.

But we made a great mistake, as multitudes often do. The fellows who make airplanes fly, and make records fall, and who drove ten thousand airplanes fifty million miles last year, were *not* the pilots. They were the mechanics. "Mechs," we call them for short. Let me tell you about this fellow as I have come to know him…and see if you don't agree with me.

Most men work for reward. There are various forms of reward; the cheers and commendations of onlookers, money, pleasure, self-expression, self-satisfaction. The pilots get all of these in some degree. What does the mechanic get? His pay ranges from twenty-one to a hundred and fifty dollars a month. He sleeps in a long shed with a hundred or more of his fellows. His is the privacy of a bird in a cage. All of his personal belongings are stored under his bunk in a four-dollar foot locker. He eats in a community mess, en masse, on fifty cents a day. His work clothes are ill-fitting coveralls. His hands are cut, and black from contact with greasy engines. He can't keep "that skin you love to touch" and maintain any intimacy with an airplane power plant. A bugle call arouses him at daybreak; he retires when the last plane is in, when his work is done.

Don't ask me *why* is an airplane mechanic, or what kind of a man would elect such a role, such a life; rather, tell me why is a hermit, wizard, nurse, nun, or saint. I don't know! There is no accounting for occupational tastes, but every time I fly I thank fate for a good mechanic.

He's no dunce, either. To learn all he knows would give many a college professor an awful headache. He gets his invaluable training over a long period of years. The school of hard knocks is his. Truly, he learns to do by doing.

This modern airplane engine is no simple mechanism. It has more parts than has the human body, and more ailments. A divine providence has fashioned your own mechanism more smoothly, coordinated your organs better, than man has built this engine. But the good engine mech knows every part, every symptom, every malfunction, as well as any doctor knows the causes of and remedies for your aches and pains. The mechanic has the trained ear of a skilled musician. But his ear is tuned to another sound; the thunderous pounding of four hundred roaring horses.

Some years ago I was assigned a plane for flight. I started to climb in, and the mech said, "Lieutenant, I wouldn't take that ship up; the engine doesn't sound right to me." I ran it up, and it delivered full power. It hit on both switches, accelerating promptly, and I couldn't detect any indication of trouble. I called for the Engineering Officer. He ran it up and marked it OK, but the mechanic still shook his head.

I took off and joined a practice formation, and soon forgot the warnings of my mechanic as we flew over San Diego Bay, past Point Loma. Twenty minutes later, the engine quit cold without warning. I set her down in the sea. Being a land plane, she soon sank. While swimming around, waiting for a rescue boat, I made one resolve that has remained with me through the years. When a good mechanic says an engine's bad, I don't fly that plane. *He's* the doctor.

These mechanics are versatile, too: mine was on that rescue boat. He has never to this day said, "I told you so," but couldn't rest until we had fished that plane off the ocean floor. Then he displayed one of his rare "human weaknesses" by spending his Sunday holiday taking it apart to see what had failed; and his expression never changed as he showed me the cause. So, you see, the airplane mechanic *is* human; in fact, he has the instincts, training, and mental ability of a surgeon. He works on a mechanism worth *ten thousand dollars*, but draws the pay of a soldier.

One of the characteristics that we always like to associate with heroes is *courage*. Here your mech is not found wanting. He'll fly with any pilot, any time, and that's something I won't do. It takes more courage to ride than to pilot the plane yourself. *You* always know what *you* are going to do; he never does. The chances are ten to one that you are not an expert automobile driver; yet, the chances are ninety-nine out of a hundred that you would feel safer driving a car yourself than riding with Barney Oldfield. So it is with flying. I have known some pilots to cool off (get cold feet, so we say); yet, I have never known a mechanic to decline to fly.

The mechanic is reliable; he is trustworthy. He takes his work seriously; he knows that human life is at his mercy. He worries, too. One of my best men, who had cared for the special planes of high officials in Washington for some years, once came to me and asked to be relieved from those duties and assigned to routine work. He said that the tremendous responsibility he carried was undermining his health. I know another mechanic who spent his last dollar to buy a flashlight, so that he could better see to make his inspection in closed hangars on dark winter days.

He takes his work seriously; he knows that human life is at his mercy.

Examine the rolls of the airmen dead, and you'll find mechanics as well as pilots. Yet, their names are forgotten. Others got the adulation, the praise, the medals, and the commendations. You can't name the mechanics whose work made possible the prominent flights, but the pilots' names are household words.

If I didn't have full confidence in my mechanics, I'd be a foot soldier. If they weren't reliable, it would be too dangerous to fly. So I say to you mechs, "My helmet's off to you." You may be ragged grease monkeys to some, but to me you're the guardian angels of this flying business.

You're the REAL air heros.

Editor's Note: 21st Century mechanics, "Forget not from whence you came." Do you live up to the reputation set by those who have gone before you?

USAF Photo by Sgt Kimberly Yearyean

When Best Laid Plans Go Astray

MSGT DALE WITCOFSKI AND TSGT BYRON OSBORN
49 MXS
Holloman AFB, NM

Even when you plan the tasks, sometimes they just don't go according to the plans made. At Holloman AFB, NM, a swing shift maintenance crew was dispatched to install the canopy on one of our F-117A Stealth Fighters. The task was proceeding according to tech data, until the canopy was swung up and over the aircraft. At that time Murphy's Law came into effect, and the electrically-powered, hydraulically-actuated Cobra Crane we were using suffered a catastrophic hydraulic and mechanical failure. The 550-pound canopy was suddenly swinging out of control and finally stopped four feet above the left intake. The rapid swinging action of the upper crane caused the crane's right outrigger to return to its storage location. The crane then fell against the fuselage with the crane's top section draped over the backbone of the aircraft, and unfortunately, the canopy came to rest on top of the left engine intake and wing surface. The shocked crane operator quickly shut down the crane, and we quickly had to come up with a new plan for this canopy.

At that time TSgt Byron Osborn and SSgt Michael Maloy, the Shift Leaders, assessed the situation and formulated a recovery plan. The crew secured the crane in its current awkward position to prevent additional damage and movement. Once it was secured, the crew chained the crane's upper section to a 10K forklift and secured the legs of the crane to the forks of the forklift. Next, they secured the canopy in its current position on the aircraft fuselage. Then they transferred the canopy's weight from the Cobra Crane to a manual Mantis Crane to provide a means to remove the canopy. At the same time the crew maintained control of the collapsed crane to keep it from shifting and causing further aircraft damage. Ever so slowly they lifted the canopy from the aircraft until just enough slack could be put into the damaged crane's hoist cable to disconnect it. Using brute manpower and guide ropes, the crew then safely lowered the canopy into the protective rails on the hangar floor. These rails are brought with the maintenance crew to protect the canopy locking latches and guides from damage, and to keep the canopy about three inches off the floor.

When the canopy was secure, they had to remove the Cobra Crane from the aircraft. They slowly lifted the disabled crane off the aircraft using the forklift, and as the crane was lifted they installed chains and cargo straps to secure the upper half of the crane to the lift cradle of the forklift. As soon as the crane was safely off the aircraft, the forklift slowly backed away, taking the wayward crane with it.

Experience and a can-do attitude paid off! In only four hours of intensive work, this highly effective maintenance team removed the damaged canopy and crane from a very expensive and critical Air Force asset.

What did they learn from this incident? The cause of the collapse was a small hydraulic leak from a control valve. This then leaked into an electrical control box and caused it to over-control the swing arm of the crane. As the weight of the canopy swung out, the right tripod leg of the crane was no longer seated, causing it to return its storage position, resulting in the crane collapse.

What was the final lesson learned? If the problem seems small at first, look further to see what else can be affected by what appears to be a minor problem.

Editor's Note: TSgt Osborn is the 49 MXS swing shift Production Superintendent and SSgt Maloy is the Exhaust System Maintenance Team Leader.

Where Is That Personal Tool?

MSGT WILLIAM L. MILLER
37 AS Production Superintendent

Is that personal tool authorized for use in Aircraft Maintenance? No! But, unfortunately many aircraft technicians will try to justify their reasons for using personal tools on the flight line and in the support shops. Here are three common excuses:

"I only use it to save time when a tool box is impractical."

"This is shop work, this isn't an aircraft."

And the big one: "I won't lose it, I'm a responsible technician."

If I may, let me tell you about some *not so* responsible technicians and where their personal tools ended up. A multi-purpose Gerber® was found in the wing root area of a KC-135. A Mini Maglite® was left underneath the pilot's floor panel on an E-3. And you know those handy-dandy neat little Leatherman® socket attachments you can buy at clothing sales? Well, one of those was found jammed in the mechanical linkage of a B-52 crew entry hatch.

Not one of these tools had any identification markings, nor were they part of the squadron's composite tool kit program. Leaving a person of some intelligence to believe that some responsible technicians did not act very responsibly. But the real kicker is, out of these three tools found, not one lost tool/object report was initiated or on file. The socket mentioned above actually caused a prior-to-flight ground mishap. When the flight crew performed its Hatch Locked and Light Out check the socket jammed the cam roller and would not allow the hatch to re-open. What if this had been an actual ground emergency, and the flight crew did not have enough time to choose an alternate means of egress? What if that Mini Maglite® left behind on the E-3 got lodged in one of the flight control bellcranks underneath the flight deck floor panels? Can you imagine trying to fly or land an aircraft with limited flight control capabilities or, even worse, none at all? Simply put, you wouldn't be flying very long, if you get my drift.

Now, you can ask the "What if" questions all day long, but is that what you really want to do? What the question should be is, "How did these tools get there?" It seems pretty obvious that using personal tools in aircraft maintenance opens the window for mishap potential and indicates a lack of responsibility for tool control. The real issue here is that personal tools *are not authorized*, and their presence should be highly discouraged in the aircraft maintenance field.

So, where does the accountability and control responsibility for personal tools begin? *With you!* Develop and/or adhere to unit tool control programs and procedures. Also, promote an environment that discourages personal tool use and encourages reporting of lost tools by de-emphasizing the disciplinary aspects for reporting lost tools. The benefits of proper tool control will help eliminate foreign object damage to aircraft, engines, aircrew training devices and support equipment. Plus, eliminate aircraft mishap potentials through effective control of *all* tools used in the aircraft maintenance environment. Who knows, you just may save an aircraft or more importantly someone's life!

FLTLT RICHARD BROUGHAM
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Reprinted from *Spotlight*, 1/2001

Everyone will almost certainly be familiar with the question, *"Have you ever had one of those days?"* The following is a story about my day off the rails, but I believe I ultimately made the right decision—as hard as it was at the time.

I was approaching the end of my tour on Hornets with a couple of major life changes: an impending marriage followed immediately by a posting to Qualified Flying Instructor's course. Needless to say, these upcoming events were causing some shifts in the focus of my attention. On the day in question I was programmed to lead a four-ship around the application pop attack pattern at Saltash Weapons Range which, in the Hornet scheme of things, is a relatively benign and low intensity sortie. The mission would be the first for the day and, combined with very tight range timings, would require us to brief immediately after the morning Meterological brief. After preparing the mission slides the previous afternoon, I planned to get to work early to deal with any last-minute changes; however, it didn't take long for this plan to depart the rails.

The next morning, a combination of a car refusing to start and then a truck with a wide load saw me arriving at work in a less-than-happy mood, and barely time to make it to the morning brief. After that it was a mad scramble, as there were changes to be made to the sortie plan due to worsening weather, but eventually we got the mission brief done. There was a further delay as I hadn't had a chance to get changed into my zoom bag; while this didn't take long, it was putting me further behind the time curve. We finally made it to the flight line to sign for the jets, where another irritant crept in. The positioning of the high- and low-drag bombs on the jets was opposite to what I had briefed. Whilst this meant just a quick pen amendment and a mental readjustment of the positioning of the bombs, it further angered me, as ultimately the error in the briefing was due to my misinterpreting the information passed the previous afternoon. So, by the time I made it to the jet I was in a less-than-ideal frame of mind, but trying to put it aside and get on with the J-O-B.

The pre-flight walkaround was quick, in fact so quick that for the first time ever I made it back to the front of the aircraft before anyone else. There was little time though to ponder this observation before the others appeared for the "thumbs up." So it was up the ladder and start strapping in, but I hadn't progressed far when the internal alarm bells started

USAF Photos
Photo Illustration by Dan Harman

ringing that something was missing...the seat pre-flight! I had completely missed it in my rush. Back out of the aircraft, do the pre-flight, back in, strap in and on with the checklist. But by now the storm clouds in the cockpit were matching those outside. As I pressed on with the checks, the alarm bells started ringing again; I had missed another item in the checklist. After correcting that omission, I took a moment to sit on my hands to try to get myself back on the tracks. As I sat there I reflected on all that happened so far; all I could think was that it was like reading an accident story in *Spotlight* with all the links of the accident chain in place. This led me to the decision that if I made one more mistake I would consider pulling out of the flight.

It didn't take long before I reached that crunch point, when I realised I had jumped the flight controls BIT check. So, as I sat there in my perfectly serviceable jet contemplating my immediate flying future, a number of thoughts ran through me. The first was an obligation to try and get the job done, otherwise I would be letting myself and the team down. Another was the cold hard rationalisation that, based on my performance to that point, the risk of continuing the flight and making another mistake—or making a poor decision which could hurt me, or worse still, others—was not justified by any overriding operational or training objective. So it was with a heavy heart, but tempered by the feeling that I was breaking the accident chain, that I handed over to Dash 3 and shut down the jet.

Once back at the Squadron I explained to the Flight Commander what had happened and, later, repeated my story at a pilots' meeting after the day's flying. It was of immense relief to me that the others supported my decision and empathised with my anxiety in making it.

One lesson learnt was that education in the form of safety videos and magazines over the years made me realise that I was in a bad situation and heading for a potentially worse one unless I "broke the chain." Another was that during peacetime training there should be no hesitation whatsoever in any decision to stop if safety will be compromised—and that the decision to do so will be fully supported irrespective of the circumstances.

As a postcript, a few years after this event I read an article in RAF *Air Clues* where a very experienced Jaguar pilot found himself in an almost identical predicament of external pressures distracting him, resulting in a multitude of errors. He also experienced the same personal conflict whether to press or not, before making the same decision as I did: handing over the lead and shutting down the jet. In both cases the decision of not to press was the correct one.

If I made one more mistake I would consider pulling out of the flight.

Editor's Note: The following accounts are from actual mishaps. They have been screened to prevent the release of privileged information.

Where did that vehicle come from? Spring is in the air and unfortunately that means more vehicle traffic on runways and taxiways for the most part. Flyers beware of the unplanned vehicle crossing.

What Do You Mean I Need A Driver's License?

At one of our deployed locations a KC-135 crew was taxiing out for a sortie and got an unplanned visitor before they even reached the runway. As they were moving down the taxiway they noticed a vehicle coming down the access road that runs adjacent to the taxiway. The big problem here is that the aircraft wing hangs over the access road preventing any vehicle from passing in the clear zone required for aircraft movement. Luckily, they saw each other and both vehicle and aircraft stopped. We now have a waiting game of who gets out of the way, with the KC-135 waiting for the vehicle to clear and the vehicle not quite clear as to what it is supposed to do. The aircrew called the tower for assistance and unfortunately the vehicle in question had no radio and couldn't be contacted. The excitement level grew. The vehicle started moving, and instead of going off the road to clear the wing, it stayed on the road and passed *under* the wing of the running aircraft. Now that was a real smart thing to do, wasn't it? Airfield ops tracked down the vehicle and removed it from the airfield.

What happened here to cause this confusion? The aircrew was totally in the right and had the right-of-way. The vehicle was from the communications squadron and was tasked to perform some maintenance on the airfield communications equipment. This task required them to access several different areas of the airfield. They were in transit from one job to another when they had the face-off with the KC-135. Why did they drive under the wing? For starters, none of the people in the vehicle had flightline competency cards and had not been trained on flightline vehicle operations. Further investigation revealed that *no one* in the communications squadron had flightline vehicle qualifications, to include the vehicle NCO. I think someone's training program needs some fixing. The deployed airfield managers have now trained the communications squadron personnel on flightline operations, and are going through all the other units to ensure all people with flightline access are actually trained and certified. Watch out for the untrained driver as you move about the airfield.

Where Are Those Weed-Whackers?

The local airfield management folks tasked three individuals to weed-whack the overgrown airfield ramp. Later in the day their supervisor needed to contact them and could not raise them via the radio. The supervisor observed some golf carts parked between the two runways, drove his two-ton truck onto the taxiway and stopped at the runway hold line. So far so good. He tried once again to raise the workers via the radio, but he had not tuned into the ground or base ops frequencies. Meaning, he could not hear or talk to the folks who controlled the airfield. The tower had just given clearance for a T-41A from the local Aero Club to land, and as the aircraft turned final the tower observed the two-ton truck approach the hold line and stop. The tower told the aircraft to proceed with caution, and the aircraft responded that they had the truck in sight. Still okay.

Just as the aircraft, with a student at the controls, crossed the runway threshold, the truck turned onto the runway approximately 2000 feet forward of the aircraft. Tower issued a go-around for the aircraft, which it safely did. The aircraft then safely landed on the other runway. Airfield operations then chased down the truck to get him off the runway and to find out why he was there. The driver was just trying to get to his workers and "thought" the runway was closed due to the weed condition. He also did not see the aircraft until it flew over him. This driver was qualified for flightline driving. Airfield Ops took his license for 30 days and he was to be retrained on airfield vehicle operations before he can get his license back. It isn't just the untrained driver that causes problems, it's those who "think" they know what is going on and don't communicate with all the parties involved. As the spring and summer approach, there will be a lot more grounds maintenance vehicles to watch out for. Keep your eyes open aviators!

What Are The Runway Crossing Requirements?

The armament shop received a call to work a gun problem on an alert bird. The crew driver called the Maintenance Operations Center (MOC) to ask the procedure to access the alert area. The MOC told the driver to call them for clearance to access the area. Here is where the problem starts. The crew driver was unaware of an access road to the alert area and thought he would access the alert area via the runway. The MOC thought the driver was talking about the alert area access road and not the runway. What we have here is another failure to communicate. The driver headed for the alert area and stopped at the runway hold line and called the MOC. Talking to the same person, the crew driver was given permission to access the alert area. He then drove across the runway without detection or incident. We dodged that bullet. The armament crew worked the aircraft and then headed back to the office. As they approached the runway he again called the MOC for clearance. This time a different controller answered and told the driver he needed to call the tower for permission. The driver, doing as he was told, called the tower and was given permission to cross. The driver crossed the runway, but used the wrong terminology in responding to the tower and forgot to tell them when he was clear of the runway. The driver, now totally confused, called the MOC to verify the procedure for access to the alert area.

This guy was unlucky; he reached the first person he had talked to earlier who again thought he was talking about the access road. Maybe the MOC needs to get better organized. After all this communication the driver needed to go back to the aircraft to finish the job. When he approached the runway, he stopped at the hold line and waited for some aircraft to land. He then called the MOC for permission to cross. MOC, thinking he was on the road, gave permission to cross. As he proceeded across the runway the tower controller saw the vehicle and told an inbound F-16 to go around. The ground controller called for the vehicle on the runway to say call sign and to hold their position once clear of the runway.

Airfield management tracked this guy down and after he explained to airfield management all that had happened, they took his competency card. In the ensuing investigation they found several problems that needed to be corrected: a training program that wasn't up to par and some unclear base instructions. Another case where those of us on the ground can ruin a pilot's day, even with the best of intentions.

Is Anybody Listening?

Here is an example where the communication broke down and we had the folks responsible for keeping the barrier in top shape being told to get off the runway. The maintenance team was doing their job, and when they got to the runway they stopped and called the tower. After several attempts with no answer they called base ops; again no answer. They drove *away* from the runway and went to the barrier hut to use the landline to contact the tower and base ops (smart guys). Unfortunately for these folks, neither the tower nor base ops answered the phone. I guess they weren't awake yet. The maintenance team then called the command post for clearance to access the active runway. The command post then gave them permission to access the runway. Now, is it standard procedure for the command post to give runway clearance? NOT! The tower then saw the maintenance team enter the runway and called the base ops folks to run them off.

The follow-up to this incident found that the maintenance team did in fact try to call the tower and base ops, but they didn't know that only the tower could grant runway access. The command post is not authorized to give runway access and should have helped the barrier crew contact the tower. There was nothing wrong with the radios or phones, and the tower and base ops were manned and open for business. Somehow no one bothered to answer. After this incident the command post was retrained on who gives runway access, and tower and base ops were reminded to make sure someone is listening to the radio and near a phone whenever the runway is active.

Editor's Note: The following accounts are from actual mishaps. They have been screened to prevent the release of privileged information.

Maintenance documentation. Why do we need to document our maintenance actions or check to see what is documented? See below for some results when documentation wasn't completed or wasn't followed and it cost US a bunch of money and a lot of extra work.

Do We Need Documentation And Follow-Up?

Before this mishap occurred, the C-130's number 1 engine reduction gearbox (RGB) magnetic plug showed the presence of metal. Unfortunately, it was out of limits and required the RGB to be changed. The unit, in the attempt to save time, decided to do a quick turn of the RGB rather than use the spare engine. The unit changed the RGB over the course of three days and rehung the propeller on the engine. Now it was time for the engine run ops check and the work was by the book. After all the pre-run checks the aircraft is cranked up with the number 1 engine being the last one started. The checks were done and the prop was run through just like tech data requires. Suddenly the ground man let the engine run team know things weren't right, and they performed an emergency engine shutdown on the number 1 engine.

The post run inspection revealed severe damage to the forward compressor section of the engine. The time savings just went out the window. The people involved with the RGB change and the engine run were qualified for the task at hand. Headquarters has an instruction that requires the wing Quality Assurance office to inspect the engine installation and the throttle linkage when an engine is changed, however, documentation did not reflect that QA had performed the inspections. First opportunity missed. The unit has a work package for RGB changes but it wasn't found in the aircraft forms. Second opportunity missed. One worker signed off the entire removal and reinstallation of seven major components on one red X in the aircraft forms. Is that an approved process for documenting your work? Third opportunity missed. An inspection of the mishap engine after the event found 26 discrepancies, four of which were grounding write-ups. There were also several other bolts, nuts and cotter pins missing. Where was the quality control and supervisory involvement in this operation? What actually caused all the damage to the engine? A torquemeter nut, whose exact imprints were found on several stages of the compressor blades, was lying in the vicinity of the first stage compressor prior to the engine start.

Bottom line, where was the documentation of the workers' actions over three days of work? Where was the quality control and supervisory oversight of this critical operation? Where was the jet engine mechanic's dedication to perform quality work? We have quality people in the Air Force, and it is operations like this that show we are human. But, if we would just follow the rules established to prevent our human nature from taking control, we wouldn't have had $240,000 in damage to an engine.

I Don't Need To Do The Safety Check.

A couple of maintainers were sent to do a stores management system (SMS) check after a cockpit side stick was replaced. Should be an easy task, right? Well, this group went out and the next thing you know, the impulse cartridges for the "fully-fueled" external wing tanks had fired! Luckily the tank safety pins were installed and they did not drop to the ground. However, they were extensively damaged from the explosives. The job guide for the SMS check reminds the user to ensure aircraft safety procedures are complete IAW TW1F-16A-2-00GV-00-1. This T.O. is specific about the requirement to have the impulse cartridges removed from the aircraft when performing maintenance that involves the stores jettison switch. To add to the maintainer's misery, the SMS checkout job guide contains a warning about maintenance on explosive-loaded aircraft, and warns, "Personnel performing this procedure shall be thoroughly familiar with the general safety requirements." Plus, the aircraft forms did not reflect that the aircraft had been disarmed. Another case where the person involved did not follow the proper tech data steps or documentation to ensure they were "safe" for maintenance, costing US over $28,000. The books are there for a reason; follow them and you are less likely to be answering the questions of a very upset supervisor and commander.

Who Finished The Task?

An F-15C was undergoing its 400-hour phase inspection and the side load scissors of the right variable inlet ramp was having some work done. The ramp had been removed for an NDI inspection and subsequently temporarily installed to facilitate other maintenance. At that time the ramp was annotated in the aircraft forms as "temp installed." Later on, as the installation task was being completed, a worker involved in the task did not sign off in the aircraft forms where he was at in the task when he stopped and left the "temp installed" note in the aircraft write-up. A couple of days later the swing shift needed to apply hydraulic power to the aircraft. The forms showed the ramp was "temp installed" and the "Do not apply hydraulic power" note had been crossed out. Good to go for the swing shift! The crew applied power and the next thing they knew the right inlet ramp was damaged to a point where depot repair was required due to a hole in the ramp skin from the ramp hardware. Resulting in $29,000 damage to an aircraft and creating a whole lot more work.

Do you think the workers involved completed the task correctly? Was the aircraft forms documentation correct about the status of the aircraft? Where was the phase dock supervision? Did people make incorrect assumptions about the aircraft status due to other people's mistakes? I think so. Assumptions are just that. Before you quit for the day, make sure your documentation is correct, as the repercussion can be felt many days later.

Support Equipment Documentation

A KC-10 required an engine change at a deployed location. The crew gathered all their equipment and proceeded according to tech data. As they were raising the engine into position, they heard a loud pop from the right rear side of the engine. As the jet tech went to check things out, they heard a second pop, followed by a shift in the engine position. That got their attention real quick. The right rear two-ton chain hoist had malfunctioned, resulting in the engine dropping about one foot. The forward section of the engine surged upward, striking the fan shroud and various ducts and tubing. The crew stopped the procedure and cleared the area. The supervisor found a replacement hoist, and they were able to safely lower the engine back to the engine stand.

The chain hoist used is inspected before every use, but unfortunately, there was no documentation to show that the hoist had been inspected as required. In addition, the hoist must receive a full proof load test every three years. The chain hoist that failed contained a considerable amount of rust. Do you think this is any indication of the care this hoist received? This hoist failed and cost US $293,000 in repair costs to a high-value refueling aircraft, due to improper support equipment maintenance and failure to document the maintenance actions on a piece of support equipment. The equipment we use to repair our aircraft is just as important, if not more, than the aircraft themselves. When I was a young airman, a previous supervisor said, "In order to succeed, you must take care of your people and ensure they have the equipment to do the job. If you can do that, then they will take care of the mission." I have lived by that rule for many years and it is a key ingredient to a unit's success. To you folks in the tool room, thanks for helping keep the aircraft in the air, but *never* let a substandard piece of equipment leave your tool room.

USAF Class A Flight Mishaps

FY03 Flight Mishaps (Oct 02-Apr 03)

13 Class A Mishaps
4 Fatalities
12 Aircraft Destroyed

FY02 Flight Mishaps (Oct 02-Apr 02)

16 Class A Mishaps
6 Fatalities
10 Aircraft Destroyed

18 Oct	✈	A TG-10D glider crashed during a student sortie.
24 Oct		An F-15 experienced an engine failure during takeoff.
25 Oct	✈✶	An RQ-1 Predator crashed during a training mission.
25 Oct	✈✈	Two F-16s collided in midair during a training mission. One pilot did not survive.
13 Nov	✈	An F-16 crashed during a training mission. The pilot did not survive.
04 Dec	✈✈	Two A-10s collided in midair during a training mission. One pilot did not survive.
18 Dec		Two F-16s collided in midair during a training mission.
20 Dec	✈	Two T-37s collided in midair during a training sortie.
02 Jan	✈✶	An RQ-1 Predator crashed during a training mission.
26 Jan	✈	A U-2 crashed during a training mission.
06 Feb		A manned QF-4E departed the runway during takeoff roll.
11 Feb	✈✶	A QF-4 drone crashed during a landing approach.
13 Feb	✈	An MH-53 crashed during a mission.
08 Mar	✈	A T-38A crashed during a training mission..
17 Mar	✈	Two F-15s collided in midair during a training mission.
19 Mar	✈	A T-38 crashed during a runway abort. One pilot did not survive.

- 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.
- Unlss otherwise stated, all crewmembers successfully ejected/egressed from their aircraft.
- Reflects only USAF 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 and ground safety statistics are updated frequently and may be viewed at the following web address: http://safety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/statspage.html
- **Current as of 04 Apr 03**.

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The Aviation Well Done Award is 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.

A1C SCOTT A. LANG
35 FW
Misawa AB Japan

A1C Lang was performing an initial certification task to get qualified on borescoping. As he performed a final borescope inspection of an F-110 jet engine, he discovered a tear on a fourth stage leading edge compressor blade. The T.O. does not require an inspection of this part of the blade, and inspection access area S-21 requires only the fourth stage trailing edge and fifth stage leading edge to be inspected. A1C Lang's extra effort and skillful positioning of the borescope enabled him to detect the damaged blade. This was the last inspection prior to the engine being released for installation in an aircraft. Further investigation revealed a crack and evidence of impending blade failure. If gone undetected, this condition would have caused further engine damage and eventual catastrophic engine failure, resulting in loss of aircraft. A1C Lang made this discovery using the inspection techniques of a seasoned 7-Level inspector and demonstrated a sharp eye and attention to detail. Misawa AB had recently experienced a Class A Mishap; the investigation of the engine wreckage attributed a fourth stage blade leading edge tear and liberation subsequently caused the destruction of the aircraft.

AMN JEFFREY HEDIN
34 FS
Hill AFB UT

Prior to the second launch of the day, Amn Hedin was assigned to perform launch assist duties for an aircraft. The pilot had arrived and completed his walkaround inspection. As Amn Hedin took an extra look in the exhaust section of the aircraft's engine, he noticed something seemed amiss. The low pressure turbine frame aft center body was off-center, and it appeared that bolts had torn through it. Amn Hedin halted the engine start, the aircraft was ground aborted and the pilot flew a successful mission in a spare aircraft. Inspection of the low pressure turbine frame aft center body is not an inspection item for thruflight inspections. Had Amn Hedin not taken that extra look, the aircraft engine start and taxi would have appeared normal. But when the pilot selected max afterburner for takeoff, a series of problems would have occurred. The fuel gushing out of the spray bars would have been interrupted by the out of position low pressure turbine frame aft center body. In turn, this interruption of ignited jet fuel would have caused hot spots to form in the exhaust liner/duct. Eventually the hot spots would have melted through the exhaust liner, causing a fire in the aft section of the F-16 jet aircraft. Amn Hedin's extra concern saved a valuable combat-ready asset, and quite possibly the life of the pilot and innocent civilians.

WW II Posters Courtesy of New Hampshire State Library
Photo Illustration by Dan Harman