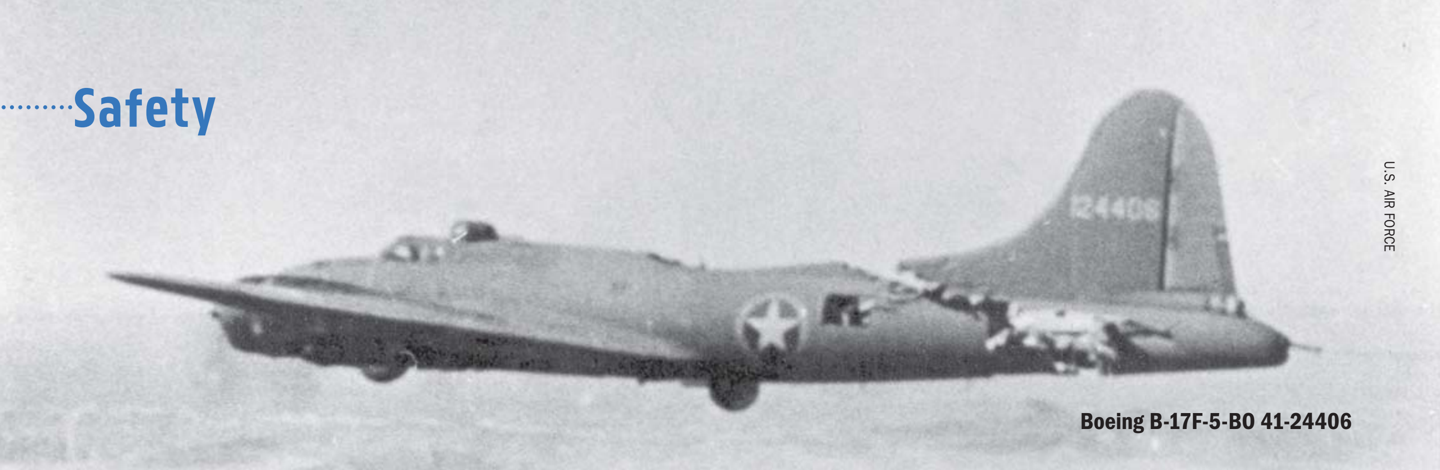


U.S. AIR FORCE

Boeing B-17F-5-BO 41-24406

Under Control

Making sure your airplane is ready **for an approach and landing**

BY **JAMES ALBRIGHT** james@code7700.com

Imagine flying a B-17 deep into enemy territory when a German ME-109 rams you, nearly slicing off your bomber's tail. You're still flying, still proceeding, but will the airplane keep together as you finally limp back to base and then configure and slow for landing? (Fortunately, for the crew who had to confront those circumstances on a Feb. 1, 1943, bombing mission, their Flying Fortress lived up to its name and touched down safely.)

Now fast forward and imagine yourself flying a business or commercial jet when an Airbus A380 crosses your path just 1,000 ft. above. Countering the upset that follows takes every bit of your airmanship and physical strength to return the airplane to straight and level flight. You suspect your aircraft may be bent. Well, as most readers know, you don't have to imagine much, since that's exactly what happened to the crew of a Bombardier Challenger 604 (D-AMSC) on Jan. 8, 2017.

Or, what if your autopilot gives you an aileron trim warning while you're happily crossing the ocean, and when you disengage it, the airplane snaps into a roll? This happened to a Challenger 604 (C-GKTO) on Nov. 18, 2017, while flying from Europe to Canada. The aircraft rolled rapidly until extreme force was applied. After an emergency landing in Ireland, a significant amount of water drained from the fuselage in an area near control cables, so the operator suspected a water leak had caused a freezing of the aileron trim mechanism.

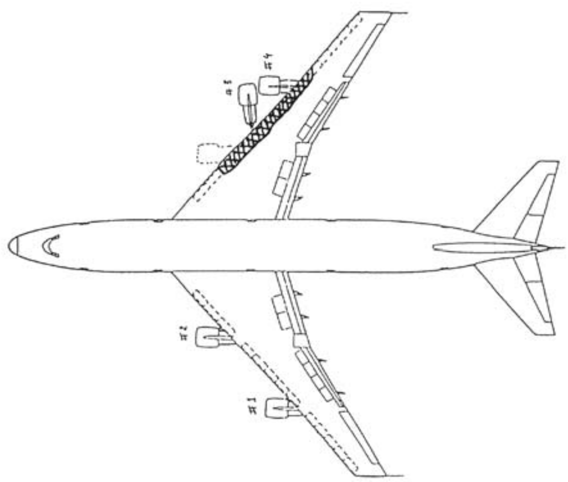
Or, what about a lightning strike? Aircraft icing? Asymmetric flaps? Hail damage? Bird strike? Debris from another aircraft on the runway? Or . . . you get the idea. As a result of any such event, you may have doubts about the airworthiness of your aircraft. Should that occur, you may need to borrow a page from military aviation: the controllability check.

Consider the 'Why?'

There isn't a lot written on the subject of controllability checks. During my earliest days in the U.S. Air Force, it was a procedure we learned because many of the era's aircraft were not as reliable as they could have been and yet we did a lot of formation flying where the risk of a midair collision was always a consideration. So, we pilots talked about conducting controllability checks and every now and then we did them. But why would we need such a procedure these days when aircraft are built so much better and our maintenance programs are more likely to find problems before they bite us when airborne?

Consider El Al Israel Airlines Flight 1862, a cargo Boeing 747 that took off from Amsterdam-Schiphol International Airport (EHAM), Netherlands, on Oct. 4, 1992. The aircraft was as heavy as it could have been under the conditions when the No. 3 engine separated from its pylon, taking out the No. 4 engine and some flight controls. The pilots definitely had their hands full; and yet they were able to fly for 8 min., maintaining altitude and changing heading when they wanted. They began fuel dumping almost immediately. But as they slowed the increasing angle of attack (AOA) also increased drag, eventually overwhelming the thrust available until they ended up behind the power curve and outside their roll capability.

The crash that resulted killed the Boeing's three crewmembers and a passenger in a jump seat, along with 39 people on the ground.



The estimated damage to El Al Flight 1862 (from the Netherlands accident report).

The accident report says, "Because of the marginal controllability a safe landing became highly improbable, if not virtually impossible." That might be true. But there are a few things we can take away from this tragedy: (1) If the airplane is flying but continued flight is questionable, try to reduce gross weight before reducing airspeed or increasing drag; (2) if faced with a loss of thrust on one side, attempt to make turns into the good engine(s) to improve roll-out capability; and (3) if you don't have to land immediately and controllability is in question, look for a sparsely populated area where you can do a controllability check.

Of course, this was a case where the problem was immediately recognizable as a dire emergency where controllability was at issue. But not all flight control problems present themselves so obviously. The case of Alaska Airlines Flight 261, for example, first appeared to be a simple matter of troubleshooting to get a failed system working again.

On Jan. 31, 2000, the crew of this McDonnell Douglas MD-83 was faced with what appeared to be a jammed stabilizer due to a faulty trim motor. In fact, the fault was a stabilizer jackscrew bare of lubrication that had ground many of the threads to its mating "acme" nut completely off. The pilots worked with technicians on the ground to repeatedly try to break the jammed stabilizer free to allow greater control for landing. When the stabilizer did break free, aerodynamic loads caused it to dislocate from the jackscrew and plunged the aircraft into an uncontrollable dive into the Pacific Ocean, killing all aboard.

We cannot fault the pilots for trying everything in their power to troubleshoot and correct the flight control; a landing with a jammed stabilizer is certainly a challenge. Few pilots have had experience with controllability checks and guidance for the procedure is rarely given by aircraft manufacturers. But we can speculate that had these pilots known the procedure, they may have been less prone to "ad hoc" troubleshooting and more apt to see just how controllable was their damaged aircraft. Maintenance procedures have been improved to prevent another case of the frozen MD-80 series stabilizer jackscrew. But not all flight control problems are mechanical in nature.

On Oct. 7, 2008, Qantas Capt. Kevin Sullivan was flying an Airbus A330 that came out of the factory with a computer design flaw that would only occur in a very rare set of circumstances. The design limitation would only happen if a "data spike" between an AOA transmitter and an air data inertial reference unit (ADIRU) repeated itself in a 1.2-sec. window. The aircraft series had logged 28 million flight hours without such an occurrence before it happened to Flight 72.

The electrical flight control system believed the aircraft was in a stall and over-speed condition simultaneously, and pushed the nose over violently enough to throw a hundred passengers and crewmembers in the cabin to the ceiling before hurling them back to the floor again. The computers ignored Sullivan's control inputs for a full 2 sec. before allowing him to return the aircraft to straight and level flight. But then the ADIRU did it again.

The crew elected to divert to Royal Australian Air Force Base Learmonth, Western Australia (YPLM), all the while unsure if their Airbus would continue to allow them to control it over the wishes of the computerized flight control system. Sullivan brought the airplane in for a safe emergency landing after performing a controllability check. Knowing the aircraft could be configured at a safe altitude gave him the confidence to attempt the landing from a controlled, 3-deg. glidepath, fully configured.

I asked Capt. Sullivan about the controllability check and he was unequivocal about its importance that day. "For the QF72 accident, our electronic flight controls were operating at an unknown level and I had serious concerns as to their veracity and my level of control, especially close to the ground," he said. "Two uncommanded pitch-downs with no amplifying information from ECAM [electronic centralized aircraft monitor] meant we were in uncharted territory, so the control check confirmed flap operation and appropriate control stick response, at altitude, prior to landing."

Consider the 'Why Not?' and 'How?'

If you have any doubt about your aircraft's airworthiness while in flight, pressing on without taking steps to reassure yourself might be an exercise in wishful thinking. Many Boeing manuals put it this way: "Troubleshooting beyond checklist directed actions is rarely helpful and has caused further loss of system function or failure. In some cases, accidents and incidents have resulted. The crew should consider additional actions beyond the checklist only when completion of the published checklist steps clearly results in an unacceptable situation. In the case of airplane controllability problems when a safe landing is considered unlikely, airplane handling evaluations with gear, flaps or speed brakes extended may be appropriate.

CHRIS FINNEY

Airbus A330-303, VH-QPA

In the case of jammed flight controls, do not attempt troubleshooting beyond the actions directed in the NNC [Non-Normal Checklist] unless the airplane cannot be safely landed with the existing condition. Always comply with NNC actions to the extent possible."

The best way to decide on a plan of attack is to firmly grasp the desired result: We are trying to get the airplane back on the ground in one piece. In order to do that, we need to get the airplane configured to as close to a normal state as possible.

▶ Will the landing gear come down in a landable condition? (Some aircraft land better gear up than with some combinations of main and nose gear. Finding out early may give you a chance to try alternate methods or, if that fails, retracting the gear to a more favorable combination.)

▶ Will the flaps extend fully, and if not, how far will they extend? If the flaps move, will they move symmetrically? Finding out early may steer you to another runway or affect the way you fly the approach.

▶ Will the airplane slow to normal approach and landing speeds without uncontrollable roll, pitch or yaw?

Flying a controllability check at an altitude low enough to simulate landing aerodynamic effects but high enough to provide a margin for recovery can be the key to answering these questions before doing it for real. Few aircraft manufacturers give their crews better insight to the process than Boeing, which publishes the following recommendations in its Boeing 737NG Flight Crew Training Manual:

▶ Unless circumstances such as imminent airplane breakup or loss of control dictate otherwise, the crew should take time to assess the effects of the damage and/or conditions before attempting to land.

▶ Make configuration and airspeed changes slowly until a damage assessment and airplane handling evaluation have been done and it is certain that lower airspeeds can be safely used. In addition, limit bank angle to 15 deg. and avoid large or rapid changes in engine thrust and airspeed that might adversely affect controllability.

▶ If possible, conduct the damage assessment and handling evaluation at an altitude that provides a safe margin for recovery should flight path control be inadvertently compromised.

▶ If structural damage is suspected, attempt to assess the magnitude of the damage by direct visual observation from the flight deck and/or passenger cabin. While only a small portion of the airplane is visible to the flight crew from the flight deck, any visual observation data can be used to gain maximum knowledge of airplane configuration and status and can be valuable in determining subsequent actions.

▶ If controllability is in question, consider performing a check of the airplane handling characteristics. The purpose of this check is to determine minimum safe speeds and the appropriate configuration for landing. If flap damage has occurred, prior to accomplishing this check, consider the possible effects on airplane control should an asymmetrical condition occur if flap position is changed. Accomplish this check by slowly and methodically reducing speed and lowering the flaps.

▶ Lower the landing gear only if available thrust allows.

▶ If stick shaker or initial stall buffet are encountered at or before reaching the associated flap speed, or if a rapid increase in wheel deflection and full rudder deflection are necessary to maintain wings level, increase speed to a safe level and consider this speed to be the minimum approach speed for the established configuration.

▶ After the damage assessment and handling characteristics are evaluated, the crew should formulate a sequential plan for the completion of the flight. If airplane performance is a concern, use of the alternate flap or gear extension systems may dictate that the check of airplane handling characteristics be done during the actual approach. Configuration changes made by the alternate systems may not be reversible.

▶ The crew must exercise extreme caution on final approach with special emphasis on minimum safe speeds and proper airplane configuration. If asymmetrical thrust is being used for roll control or pitch authority is limited, plan to leave thrust on until touchdown.

In addition, the flight manual for the U.S. Air Force's C-17A Globemaster III also provides several valuable tips on how to do a controllability check:

▶ Conduct the check at 5,000 to 10,000 ft. AGL, if possible.

▶ Monitor control stick and rudder pedal position, as well as control surface movement indicated on the MFD (multifunction display) CFG (configuration) format, to determine control authority remaining.

▶ The pilot must use prudent judgment in making speed and configuration changes.

▶ WARNING: If control authority degrades rapidly or required control input approaches the limits of authority about any axis, with configuration change and/or airspeed variation, immediately return to a configuration and speed at which adequate control authority is known to exist.

▶ As airspeed and configuration are varied, be alert for aircraft buffet. Do not decrease speed below the minimum configuration maneuvering speed.

▶ Factors such as turbulence and crosswind must be considered when determining a configuration and speed with adequate control margin best suited to approach and landing. Apply estimated crosswind controls required for landing

C-17 on approach to Royal Air Force Brize Norton (EGVN)

MATT BIRCH

to test effect on flight characteristics.

▶ Once the limiting configuration and minimum safe speed have been determined, fly that speed plus 10 kt. during approach and landing. Refer to Abnormal Configuration Procedures, as appropriate.

▶ WARNING: The speed must never be decreased to the point at which full control deflection is required about any axis since there may be no recovery capability beyond this point. This can occur with no unusual stick or rudder positions since EFCS is applying controls with no feedback to the pilots.

▶ The approach speed must never be allowed to decrease below the minimum safe maneuvering speed as determined from this check. Routinely, fly minimum safe speed plus 10 kt. as the target approach speed.

Consider Developing Your Own Controllability Check (Just in Case)

I've taken these Boeing and C-17A procedures and added many from my Air Force functional check flight manuals to come up with my own generic controllability check. I've never had to use them "in the heat of battle" but if that day ever comes, I'll be ready.

Brief crew duties, expectations, safe attitude/AOAs and "knock it off" criteria:

(1) One pilot flies the aircraft while the other monitors aircraft status and makes note of performance. While pilots can exchange duties (i.e., each pilot exercises the flight controls), one pilot must always be designated as the pilot flying.

(2) The expectation for each step of the process must be verbalized prior to the step. For example, "We will now extend the speed brakes slowly and smoothly; we don't want to see the aircraft roll on extension or retraction and we want to see the retraction completed to a clean wing."

(3) Both pilots should have in mind where the aircraft pitch, roll and yaw should be for the maneuver to be attempted. If the aircraft is equipped with a flyable AOA instrument, pilots should have in mind where the AOA should be. With or without an AOA indicator, pilots should have knowledge of where the pitch should be. For example, "We do not expect to see the nose pitch up or down during speed brake extension. The AOA should remain steady."

(4) Both pilots should agree on results that will cause an abort of the maneuver, the so-called "knock it off" call. Since you are conducting a test, you should have in mind what constitutes a failed test and how to extract yourself from that situation safely. For example, "If the aircraft rolls or exhibits a pitch change of more than 5 deg. during our slow extension of the speed brakes, we will stop the extension, evaluate and retract the speed brakes."

What follows are examples of adverse behavior that might be worthy of aborting a procedure:

▶ Unexpected aircraft roll, or a roll at a rate or direction unexpected with intentional movement of the ailerons.

▶ Unexpected pitch changes.

▶ Adverse yaw (not produced by rudder inputs).

▶ Aircraft vibration or shuddering.

▶ Flutter (a resonant vibration of a control surface or its surrounding area).

▶ Control jamming or sudden roughness to the controls.

Validate primary flight controls and pitot-static system:

(1) Descend to 15,000 ft. (desired).

(2) Slow to 250 KCAS.

(3) Validate all airspeed indicators and altimeters are in agreement. You can check these against your GPS; the altimeter will generally be within a few hundred feet and the indicated (or calibrated) speed should be about 20 or 30 kt. higher than the ground speed corrected for wind. You can use this exercise to identify faulty instrumentation.

(4) Select flight control synoptic pages.

(5) Each pilot should, in turn, exercise one axis at a time. Start at neutral and look for any looseness. Using smooth and small inputs, exercise the control and look for any binding and other signs of abnormality.

Validate speed brakes, flaps, landing gear and low-speed flying characteristics:

(1) Look up approach speeds for each possible flap setting, given the current weight and altitude.

(2) Descend to 10,000 ft. (desired).

(3) Slow to 250 KCAS.

(4) Extend the speed brakes. Look for symmetrical deployment and decelerate to what should be close to a no-flap maneuvering speed.

(5) Stow the speed brakes. The speed brakes should stow symmetrically without any sign of floating.

(6) Adjust the thrust to start a 500-fpm descent while holding your no-flap maneuvering speed.

(7) Extend each notch of flaps as the target speed permits, allowing the aircraft to decelerate with the increased drag. Adjust the thrust to allow the speed to decay about 1 or 2 kt. per second, no higher. If at any point the aircraft begins to roll or buffet, discontinue the maneuver, taking note of the speed and configuration.

(8) Once the aircraft reaches your target approach speed, accelerate and clean up to the extent necessary. You might consider keeping the landing gear and some of the flaps extended, depending on the situation.

Plan your approach and landing:

You should use the data obtained from the controllability check to learn which flight control components can be trusted and which will require an adjustment to normal approach and landing procedures. If a higher than normal approach speed is dictated by adverse flying characteristics, be mindful of the aircraft's touchdown attitude (to prevent a nose-first landing) and stopping distances.

Keep in mind that you should never find yourself on approach at an airspeed lower than already demonstrated during the controllability check and that you should never find yourself needing full control deflection in any axis. If either event occurs, you need to speed up.

The Benefits of a Controllability Check

In some cases, a controllability check will only confirm that you have a perfectly flyable airplane and that will give you the confidence to approach and land using normal configurations and techniques. In other cases, however, the check will reveal you may need to alter the configuration and fly at higher speeds. But there is at least one more benefit: The time required to fly the controllability check will force you to slow down and be more deliberate about the steps to follow.

So, once again, imagine yourself flying an aircraft where the ability to fly an approach to landing is in doubt. You have sustained damage from hail, icing or a foreign object. You may have had a mechanical, electrical or computer malfunction. For whatever reason, you are no longer 100% sure about the airplane's airworthiness. It seems to me that there is almost never anything to lose by doing a controllability check unless you are on fire, running out of fuel, the weather coming down or there is some other time constraint. And there are times when doing a controllability check can be a lifesaver. **BCA**