



# Views from a JetProp

## The Silent Emergency: Detection, Avoidance and New Solutions

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Primary attitude instrument failure remains a significant cause of aircraft accidents, and the PA46 family of airframes is not immune to the problem. The KFC150 and KFC225 autopilots found in all pre-2000 model year PA46 airframes rely on the KI256 vacuum-driven attitude indicator for pitch and roll reference. If either the vacuum source fails or the instrument itself goes belly up, the autopilot has no way to detect the failure and will eventually roll the plane into a high speed spiral dive. That specific scenario has led to structural failures of more than one PA46.

### Early Warning Signs of Failure

Understanding the behavior of the KI256 and autopilot at the onset of a failure can help avoid the often-fatal consequences. A conventional attitude indicator operates under the principle of gyroscopic rigidity in space. When spun up internally to over 10,000 rpm, the attitude instrument will erect and maintain the familiar blue over

brown indications we have been trained to trust over our internal equilibrium.

When the power source is removed, or internal friction degrades the rpm of the instrument, the instrument will begin to lose its rigidity in space. The first indication the KI256 will show will be to very slowly raise the artificial horizon above the natural horizon, showing a nose-low attitude. If the autopilot is flying the airplane in level flight, this will result in a long-chord pitch oscillation, where the autopilot will very slowly climb in an attempt to hold pitch attitude, and then correct for the altitude deviation with a rather quick pitch down to regain the captured altitude. If a human pilot is flying the airplane, they will also climb the aircraft while maintaining an apparent level pitch attitude, and then be forced to correct nose down to maintain assigned altitude. Early recognition of this symptom is essential to avoiding the high speed spiral dive that comes next.

Approximately two minutes after the false nose-low indication begins, the KI256 will begin to roll over, causing a false wing low indication. The autopilot will begin to roll in an attempt to correct the indicated bank attitude. As the true bank angle increases, the decreasing vertical component of lift will cause the nose to drop. The stage is now set for a fatal accident. The aircraft will already be in a high speed, nose down, wing low spiral dive with rapidly increasing airspeed and rapid loss of altitude.

Although a high speed spiral dive does not itself cause an in-flight break-up, the recovery from this dive can easily lead to over-stress of the right wing and subsequent failure of wing lap joint where the wet wing attaches to the one piece main spar just outside of the main landing gear.

### Mitigation Strategies Before Failure

We can take several steps as aircraft operators to guard against an attitude instrument failure. Flight Safety reports that 50% of professional pilots entering recurrent training are unable to maintain control of the simulator when flying only on the turn coordinator and altimeter as the primary bank and pitch references. Hand flying on the copilot attitude instrumentation while using the pilot HSI is also exceptionally difficult for pilots without recent practice and proficiency flying in this fashion.

#### *Install an Electric AI*

The most important mitigation method is to replace the turn coordinator with an electrically powered attitude indicator with a slip/skid ball. This has been a legal substitute for the turn coordinator for several years and reduces the pilot workload in an attitude failure to a level manageable by most pilots. Even with a second (correct) attitude indicator in the primary pilot scan, the distraction of incorrect indications from an instrument we have been trained to trust completely cannot be overstated.

When a safety pilot is available, practice flying the aircraft on your installed standby instruments in actual IMC, beginning from the top-of-descent point. Do not allow the safety pilot to operate radios, GPSs or





offer any assistance unless you exceed a 30 degree bank angle or deviate from your altitude by more than 100 feet. Recent flight experience dealing with this failure in non-emergency circumstances will greatly increase confidence and competence in juggling the numerous aircraft management tasks necessary in addition to maintaining aircraft control during a descent and arrival.

#### *Know and Watch for Warning Signs*

Know the warning signs of actual instrument failure and be prepared to identify long-chord pitch oscillations and confirm aircraft pitch and bank attitude with co-pilot or standby instrumentation as early as possible.

Also be aware of very early warning signs of failing KI256 attitude indicators. These symptoms will generally show up a couple hundred flight hours or more before complete instrument failure. Watch for failure of the instrument to fully erect within the first three minutes after engine start. The autopilot may hold the left side of the heading bug and track to the left side of the LOC or GPS course when the KI256 is not fully erect. When operated in ROLL mode (the natural, un-announced lateral mode of the autopilot) the aircraft will slowly turn left as evidenced by steady reduction of your GPS ground track numeric indication.

If these symptoms become evident, schedule an autopilot calibration with an

avionics shop, which will necessarily involve an evaluation of your KI256 for suitable erection and rigidity. If you are lucky, this two hour process will cure your left turning tendency through calibration and not condemn your KI256 to an expensive overhaul. Once a factory-new KI256 instrument is overhauled, they often begin to fail again within 200-400 flight hours. Not all avionics shops have the expensive calibration bench equipment, so verify this capability before scheduling a visit. Only two shops in all of Washington State for example are so equipped.

### **Mitigation Strategies During a Failure**

Once a KI256 failure is recognized, your first priority should be to restore instrument function if possible. Check your vacuum gauge, and if this is the cause of failure, activate your standby vacuum if flying a JetProp or un-modified Malibu. If your vacuum pressure is normal, then you must take immediate corrective action to block the instrument indication with a panel cover and disconnect the autopilot.

#### *Ahead of the Curve*

This will be the moment you (hopefully) congratulate yourself for practicing partial panel flying in the previous 90 days and for having readily available the panel cover in the map pocket. An inexpensive black rubber suction cup instrument panel cover, available from any pilot shop, will reduce pilot workload during this failure mode by over 50%. The reduction in mental workload required to maintain control of the aircraft is equivalent to the workload reduction experienced when climbing out of IMC into visual conditions. Every pilot and every aircraft should have a panel cover when flying in instrument weather while relying on a KI256 attitude indicator.

If you are VMC, attempt to remain so until

landing the aircraft. Whether or not this is possible, advise ATC that you have a primary attitude instrument failure. If IMC, request vectors or clearance to VMC conditions, even if that involves climbing the aircraft. Minimizing your exposure to IMC will greatly increase your chances of success. Extension of the landing gear will increase the roll stability of the aircraft significantly.


#### *Behind the Curve*

If you do not recognize the failure until after the aircraft has entered a spiral dive, extend the landing gear immediately, regardless of indicated airspeed and gear operation limitations. Your life is at stake and gear doors are the least of your worries. Reduce the throttle to flight idle, and level the wings by reference to your standby attitude indicator or turn coordinator. The PA46 is exceptionally strong in level flight, but not so much in a 60 degree bank. After you have restored a wing level condition, smoothly and slowly pull back on the yoke until the aircraft reaches a slight nose low pitch attitude, as evidenced by either your standby attitude indicator or your VSI showing a descent rate of 1000 FPM or less. Trim the aircraft to a neutral pitch force. Only then, increase power to your normal holding power recipe (20" manifold in a Malibu, 400 lb torque in a JetProp and 500 lb torque in a Meridian).

The fatal mistake in this terrifying situation is to pull back on the yoke to correct the overspeed before bringing the wings level. While you may succeed in arresting the descent and possibly even gaining a few hundred feet of altitude, your inputs can very easily break off the outboard upper wing leading to an unrecoverable fatal corkscrew to the ground.

### **New Technologies to Remove the Source of Failure**

Until March of 2009, the KI256 had no certified replacement. However, Garmin has now certified the GAD43, which is in conjunction with a Garmin 500/600 EFIS installation approved to replace your KI256 attitude outputs with a solid state "gyro on a chip" ADHRS system.

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The solid state ADHRS is vastly more reliable than a mechanical attitude gyro and features internal failure detection that will disconnect the autopilot immediately

upon any interruption of power or internal error.

If your budget does not allow this upgrade to your aircraft panel, the Aspen EFIS system will provide a ADHRS-based primary pilots attitude reference while leaving the autopilot still driven by the KI256. The chances of a KI256 failure catching a pilot by surprise reduce to nearly zero as the pitch and roll deviation will be immediately recognizable by the pilot displayed on their primary visual

attitude reference. Aspens claims to be nearly ready to offer a replacement for the KI256.

If neither of these glass cockpit upgrades can be installed, your next best option is to go back to the basics mentioned earlier: place a panel cover in your map pocket and replace your turn coordinator with an electric attitude indicator. To do nothing ignores the accident record and glaring safety deficiency in your instrument panel. Your family, heirs, associates and passengers all deserve a better alternative than the stock instrumentation delivered with your aircraft.

KI256 instrument failure has claimed the lives of enough PA46 aircraft occupants for our fleet's lifetime. The Pilot in Command is responsible for recognition, mitigation and ultimately permanent resolution of this failure mode. Training to handle the failure and adopting technologies to avoid the worst impacts of such failure are worthy expenditures of your time and money.



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