Upsetting: Safety Chain

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What would be an indication of a Rudder Trim runaway?

A. Aural unidentified tone
B. Aural continuous disengage tone
C. Aircraft beginning to yaw left or right
D. Aircraft beginning to roll left or right
E. B & C

This is one of the questions I give when doing recurrent training. Think about the possible answer. It will be addressed in this article.

I have previously written articles titled “Upsetting” regarding LOC-I [Loss of Control – In flight] as it relates to PC12 accidents. The POPA fall 2017 article touched on the last two U.S. commercial fatal PC12 accidents while the other was based on the conclusion of the 2012 Lake Wales, FL fatal PC12 accident. Note: The accident that occurred last April is still under investigation and my thoughts on what may have contributed to that accident are mine alone.

It continues to disturb me as to how we can lose control of this aircraft during any phase of flight but “stuff” does happen! However, I can still attempt to analyze what could be causal, especially regarding the last two accidents by applying some basic logic and known facts.

Both of the last two accident aircraft were being flown by commercially rated pilots. Both aircraft were operating under a night, IFR flight plan. Both flights, I believe, did not have much, if any, reference to the horizon due to weather and lack of nearby city lights. After takeoff both had climbed to approximately 3000 feet AGL and upon checking with local ATC both were asked to reset their transponders.

And then no further communications or radar contact.

I have pointed out the general external commonalities. What about internal? What was happening on-board the PC12s? It's hard to say for sure without recovered data but what would/should be common to this phase of flight?

1. Clean aircraft, climb power or reducing from climb power - not sure.

2. On autopilot or hand flying - not sure.

3. Airspeed at least 120 KIAS but since leveling off should be higher - not sure

4. Yaw Damper - ON, *probably* unless forgotten or not functioning. Not likely

What I have listed is implying that the "chain" may have included the possibility of a rudder/yaw damper runaway causing the aircraft to enter a stall/spin before the pilots could recognize what was happening. Is this an autopilot issue or an auto-trim issue?

In previous accident reports the autopilot has been mentioned, without proof, of possibly being a factor in some accidents.

The autopilot for the Legacy PC12 and NG both operate in the traditional three axis flight mode. Basically both autopilots have a computer for processing information from an Air Data Computer (ADC), AHRS or ADAHRS, flux valves, HSI or PFD and a Navigation source. Both autopilots have Pitch, Roll and Yaw servo-actuators. These actuators have a built in slip-clutch feature allowing the pilot to override the servos, if needed and Autopilot Disengage switches (red buttons). While the autopilot is engaged the trimming commands to alleviate Elevator/Rudder (Yaw) servo-actuator pressures derive from the autopilot computer. The Aileron servo-actuator moves the aileron system only. Aileron trimming is not a function of the autopilot, pilot only inputs. A component of both autopilots, called the trim adapter, operates the pitch servo (actuator) of both autopilots while the NG autopilot also operates the Rudder/Yaw servo actuator. The trim adapter has one other important feature – when the pitch trim is *operated manually*, and a pitch trim runaway is detected, in the Legacy an aural warning will be heard[Medium Pitch Warning Tone aka Warble Tone] while in the

NG a voice callout “Trim Runaway” as well as a CAS message [Pitch Trim Runaway]will sound.

Since the Aileron trim is not automatic and not used often, no aural warning or caution is installed in either aircraft series.

This brings us to the Rudder Trim/Yaw Damper. The Yaw Damper can work independently of the autopilot so it is also referred to as auto trim.

It is used primarily to offset the left-turning forces associated with a single propeller driven, high torque aircraft. Secondarily, but still important, it maintains coordinated flight while in a turn due to inherent slipping or (possible) skidding without the pilot attempting to apply the correct amount of rudder. Thirdly, at high altitude the yaw damper helps along with the strakes to avoid the possible Dutch Roll effect.

What “tells” the Yaw Damper to operate? For this particular axis-of-flight [vertical], a gyro. The type of gyro used originally was a rate gyro, which measures the rate of rotation, or angular movement about its input axis. Better than a gyro is the AHRS, which has three rate sensors mounted to measure the three axis-of-flights. As technology has progressed, the NG Autopilot for example, newer rate sensors are using MEMS (Microelectromechanical Systems) within the ADAHRS. Your cell phone has them!

So what’s the correct rate? How does it know to change based on Torque/P-factor? PFM… (Pure Factory Magic)! Actually I would think it’s determined by manufacturers of yaw sensor and the type of aircraft.

This now brings this article to my “chain” thought.

First, to answer part of the question from the beginning of this article - there is NO aural warning for a rudder/yaw damper runaway. Should there be? I believe the reason one is not present is due to the amount of rudder trim movement during takeoff and climb at high torque/lower airspeeds. And of course once leveling or with intermediate power reductions, level offs back to climb power

can make several rudder trim movements that could be construed as a possible runaway by a sensing system.

If no aural warning then how else can the pilot recognize a rudder/yaw runaway? By the “butt” sensor? Pilot location does not lend itself to this due to position relative to center of axis. Without reference to horizon the pilot could look at the trim indicators and/or the inclinometer [ball] – Legacy aircraft without Primary Flight Displays (PFD’s) or the slip indicator (bar) on the PFDs. The Legacy Central Advisory Warning system (CAWS) also has either a Blue or Green “AP TRIM” indication when the Rudder/Yaw or Stabilizer trim are operating, either via the autopilot or just if yaw damper is only used – Auto Trim.

Can this happen with the autopilot ON? I believe anything is possible. But at what point would that be and what are the flight control conditions? Besides possible internal “glitches” an external factor to consider would be wind shearing confusing or causing changes not immediately sensed by the pilot.

Back to the “chain”. The two accidents are eerily similar with the most current investigation outcome probably with the same conclusion as the one before – spatial disorientation with contributing factor due to distraction - transponder reset and possible autopilot issues.

But shouldn’t they have been able to recover? With the possibility of no outside horizon reference we would think – look at the HSI, instrument flight. But with possible unknown internal/external factors as well as the probable sudden roll due to excessive rudder input and possible high torque/low airspeed possibly not. I suspect all greatly contributed to the unfortunate outcome with little time to react. And not enough altitude if pilot was able to react.

What can be done? If you EVER suspect a flight control issue: FTFA [Fly the Flipping Airplane]! Reduce power/level off. Feet on the pedals. Take hold of the control yoke; press the A/P Disc button. If not sure of relief, press the Trim Interrupt switch as well! Remember, torque is the biggest enhancer to an upset! Also, when in doubt about possible trim issue, including yaw damper only, press the Trim Interrupt switch. Removes ALL power to all trim/autopilot functions.

Note: We are able to overcome the autopilot servo-actuators via the slip-clutch with the rudder slip-clutch requiring the greatest amount of force to overcome.

Can we fly via the autopilot without the yaw damper engaged? Yes, but only after first engaging autopilot and then selecting the yaw damper OFF. Can we manually toggle the rudder trim while the autopilot is engaged? In Legacy aircraft yes you can but the AHRS will only re-correct to what is considered correct. With the NG toggling of the rudder trim will disengage the autopilot.

Again, ANYTIME you feel/sense the aircraft is doing something unusual, with the autopilot engaged – disengage by pressing the A/P Disc button and FTFA! Pilots hate the disengage tone but what is worse? If hand flying you should be able to more quickly feel control force changes to alert to a possible rudder trim/yaw runaway – in this case by also pressing the A/P Disc button. But what if while flying by hand you are temporarily distracted?

In either instance if not sure, after holding the control yoke, press the Trim Interrupt Switch.

Statistically, with nearly 7 million flight hours and counting if this was a known issue I wouldn't be writing about this possibility since it would have been corrected. But I do believe it IS being thoroughly investigated by all concerned parties.

"A safe pilot is always learning"

John Morris - ACFT Services

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