Manual Trim, Autopilot Trim or “Auto Trim”?

Pilatus recently released new revisions to the Legacy PC 12s (MSN 101-888, except MSN 545) regarding Trim Runaway procedures. Even though the NGs were not included regarding this particular procedure this subject is important for all PC12 operators.

The revision has to do with the possibility of Name used on the Legacy Triple Trim indicator, “an Auto Trim runaway”. What is an Auto Trim runaway? All POHs, Section 3 - Emergency Procedures have had procedures for Trim Runaway and Autopilot/Automatic Flight Control System [AFCS] (Autopilot Malfunction) but nothing listed as Auto Trim malfunction or runaway. That is because it has to do with the Rudder/Yaw Damper function and this function *is* the Rudder Trim System and therefore is part of the Electrical Trim/Trim Runaway group.

But isn’t the Yaw Damper part of the Autopilot System? It is, but only when the Autopilot is engaged. Otherwise, as we should all know, the Yaw Damper is usually engaged independently until Autopilot activation and probably after autopilot disengagement.

So am I saying that if the Autopilot is engaged and there is the possibility of a Rudder/Yaw runaway that the autopilot will detect this and fault protect the system? Is that why it isn’t listed with the Autopilot malfunction group? Maybe yes, maybe no. Here is a little refresher regarding the Trim/Autopilot systems and their protection devices in use with the Legacy and NG PC12s.

All PC12s have three-axis manual electric trim control with visual indicators for each axis (Triple Trim Indicator with Auto Trim indications for Legacy PC12s and NG Trim System Displays on the system MFD). Rudder trim is manually activated by the 2-way toggle switch located on the Power Control Lever (PCL). Aileron and Stabilizer manual trims are controlled/activated from the control yoke 4-way toggle switch with the trim engage trigger required to be pressed for electrical power. With the exception of manual Stabilizer Trim alert function, all manual trim runaways will only be presented to the pilot by visual physical cues of flight control loading and/or flight path deviations. The good news is that since the pilot is manually trimming then he/she should be manually hand flying the aircraft at that moment so he/she should be immediately aware of a trim runaway. The bad news is that depending on which manual trim is running away recognition may be delayed past a safe point of recovery. This is why the authorities required, and why Pilatus added, additional safety measures for manual/auto Stabilizer trim operations.

For a Legacy manual Stabilizer Trim runaway we will receive an aural warning tone, referred to as the “warble” tone in Systems but for the first time, with this current revision, it is being referred to as the “medium pitch warning tone” with no other visual indications. For the NGs a manual Stabilizer Trim runaway will have a voice callout (continuous) “Trim Runaway” with a CAS message “Pitch Trim Runaway”. Note: In ALL cases of suspected manual trim runaway the *immediate* action is to select the Trim Interrupt switch from NORM to INTR. More on the Trim Interrupt later

The Bendix/King (now Honeywell) KFC 325 Autopilot system, developed in the 1980s and still widely in use, was selected for the Legacy PC12s since it had three-axis control via servo-actuators with slip clutches allowing the pilot to overcome an autopilot

mistrim or disconnect failure with control yoke/rudder pedal force. For autopilot trimming the Aileron (Roll) servo-actuator controls the Aileron wing down/up system, not the Aileron Trim-No auto trim function with the Aileron Trim system. The Rudder (Yaw) Servo-actuator controls Rudder left/right movement. The Rudder servo-actuator has a dual function with the primary function being rudder movement and secondary function to signal the Yaw (Rudder trim) actuator for load relief of the Rudder servo-actuator. Whenever the Yaw trim actuator is activated the Triple Trim indicator will illuminate an Auto Trim light above the Rudder trim indicator and display a CAWS Blue (Series 9) or Green AP TRIM advisory. The Elevator (Pitch) servo-actuator controls the elevator up/down movement. One of the Part 23 required safety features for Trim able Horizontal Stabilizer aircraft (especially single-engine) is a monitor, in this case the Pitch Trim Adapter. The trim adapter's primary function, as labeled on the circuit breaker panel, is to monitor the autopilot pitch-servo actuator for load relief via activation of the secondary stabilizer motor. The secondary function is to monitor the stabilizer trim motor for possible out-of-trim control forces or other issues relating to that circuit. Whenever the Stabilizer secondary motor is activated the Triple Trim indicator will illuminate an Auto Trim light above the pitch trim indicator and display a CAWS Blue (Series 9) or Green AP TRIM advisory. If the Trim Adapter senses a fault it would command the KFC 325 to remove all command inputs to the autopilot servo-actuators but NOT disengage the servo-actuators (autopilot). This causes the autopilot to maintain the current Flight Director path until disconnected. The usual result would then be a CAWS (red) AP TRIM and an audio tone (also a voice callout with Series 10 aircraft "Warning, Autopilot Trim") as well as a red PTRM indication on the EFIS EADI and a red TRIM indication above the TEST button on the autopilot control panel. The pilot is then *immediately* required to FIRMLY GRASP the airplane control wheel, press the Autopilot Disengage switch/button (on the control wheel), RETRIM and pull the Autopilot Circuit breaker. AND (not written but)…Fly the airplane!

The NGs have the Honeywell Automatic Flight Control System (AFCS). This system has all of the same general functions/servo-actuators as the KFC 325 with a major exception of the Stabilizer Pitch Trim Adapter and system indications. The System's MFD only indicates when a particular trim is in-motion (or faulted) with no "Auto Trim" or AP Trim advisory. The AFCS Trim Adapter also monitors the Yaw (Rudder) Servo Actuator. With this system, besides monitoring/activating normal control functions, if an Auto Stabilizer Trim or Rudder Trim runaway occurs, the autopilot will similarly stop the servo-actuator(s) from engagement, as well as give an audio callout "Trim Runaway" and CAS message "Pitch Trim Runaway". A more robust means of identification but as with the KFC 325 procedure, the pilot must take manual control of the aircraft, press the A/P DISC switch on the yoke and pull the A/P circuit breaker.

So far it appears that awareness of trim runaways will come by either manual control feel after activating a trim function along with an audio alert for the stabilizer (and also visual for NGs) or by audio/visual alerts while using the autopilot.

That leaves the Yaw Damper/Rudder trim (Auto Trim) working independently. It is possible, especially with the Legacy PC12s and the KFC 325, to have an autopilot malfunction followed by the initial phase on the emergency procedure, by pressing the A/P disengage switch and still have the Yaw Damper/Rudder trim running, since the Trim Adapter is not monitoring the Yaw/Rudder trim. It is also possible for all PC12s

flying without the autopilot engaged, for the “Auto Trim” to continue to run since the both types of Trim Adapters are a function of the autopilot circuit and are only monitoring the “Auto Trim” while in autopilot mode. Note: the A/P Disc works for disconnecting the “Auto Trim” normally but is not a power interrupt if frozen/welded.

That brings us back to the Trim Interrupt. Since teaching the PC12 and many older aircraft that had a similar function, I have referred to the Trim Interrupt as the trim master simply because selecting this switch to INTR (interrupt) causes ALL power to the trim systems *and* the autopilot to be removed. Period. So the revised procedure, for Legacy PC12s only, after an indication of a Trim Runaway, has the pilot select the Trim Interrupt to INTR, then check to see if the Triple Trim indication and/or CAWS AP TRIM advisory is *still* ON. If so, pull the A/P Trim circuit breaker and then Trim Interrupt back to NORM.

My concern regarding this procedure, as well as any possible trim/auto trim/autopilot malfunction is recognition of the event, in a timely manner, without jumping to conclusions, while simultaneously maintaining control of the aircraft, since we might be near terra firma or any possible flight attitude at the surprise moment. Most of the younger pilots may not be aware of the older autopilots having the A/P disconnect button, that while held down, also interrupted the power to the trim systems. This allowed the pilot to fly the plane manually while “figuring it out”. I have watched many pilots try this (in a PC12) when simulating a trim runaway, in the box as well as live. It doesn’t work. Yes, an autopilot malfunction affords us the ability to overcome the servo-actuators due to the slip-clutch features while simultaneously disconnecting the autopilot via the A/P Disc while keeping the manual trims still available. As a result the Trim Interrupt has never been included with an Autopilot emergency procedure. Would it hurt to use [Trim Interrupt] during a possible autopilot problem since the pilot should be reacting by first grasping the control yoke?

Conclusion: when in doubt, “hand” fly the airplane and disconnect/interrupt, FIRST before wondering what is going on and why.

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