Commentary on 14 CFR, part 25 para 1329.

There is significant discussion in both the NPRM and the draft advisory circular regarding human factors, system incompatibilities, methods of upset, etc. Icing is also mentioned and is to be considered regarding its effects upon the FGS, i.e., how the system operates in icing conditions. Not mentioned however, is that equally, as an autopilot can mask the effects of icing, so can icing mask or impair the handling qualities of an autopilot. This seems apparent in the number of aircraft which suffer a mishap attributable to loss of control and possible icing when icing conditions are marginal or do not exist.

There is also little discussion regarding the known frailties of the current systems or component items as they are implemented. An example would be the 737 rudder boost package or hydraulic servo actuator reversal, when a worn or out of tolerance flow control valve can be positioned such that an input command can result in the opposite reaction of the rudder.

Similar to this is the various monitoring which has been implemented into several generations of autopilots. Many of these continuously monitor either G forces, pitch rates or roll rates or all of the above, and upon reaching a predetermined point will momentarily remove power from the autopilot servo mechanism's without annunciation. When this occurs, it is generally due to turbulence which in itself can place an aircraft in a very precarious position regarding attitude, airspeed or G forces. This action is taken by the system (as designed) to prevent the system from creating undue physical stress upon the airframe and is generally an unknown feature and totally un-annunciated to the flight crew. The result is a flight crew that is trusting of the autopilot because it has been engaged and has flown the aircraft through previous minor upsets. The typical pilot will allow it to remain engaged through even heavier convective activity, unaware that during rapid rates of change in attitude or higher vertical accelerations the aircraft is not being controlled..

When this monitoring off of the autopilot occurs, the perceived result in the system is to allow the affected servo mechanism's to release control of the control surfaces, which at the time of power removal may be in an "out of trim" condition. This releasing of the physical load from the aerodynamic surfaces results in the near instantaneous reversal of the direction of the servo capstan. When this happens it can result in a cable jump resulting in a jammed control surface. With this type of control jam, there is no protection resulting from internal slip clutches within the servo mechanism itself and the pilot MUST either "pull it through" or break the bridle cable which would result in large control movements at high airspeeds and probable subsequent damage to the aircraft.

The probability of a control jam may be further exacerbated by other factors. The fact that the aircraft is already in climb or dive with a potential for a negative G condition which would allow uncontrolled movement of a bridle cable, and also the failure of some systems to completely disengage their servo mechanism from the control surface when under loads.

I am aware of three autopilot manufacturers at this time which implement the philosophy of momentarily monitoring off during flight without the knowledge of the flight crew. I am sure that there are many others as this seems to be a prevalent philosophy of current autopilot manufacturers and indicates a lack of understanding on their part regarding the need for control in what could be critical situations nearing upset conditions.

In any case, I do not believe that control, even momentarily, should be removed from the autopilot without adequate warning to the flight crew in the form of a clear and obvious annunciation in the cockpit. This time lapse may amount to several seconds during which the airframe may be further approaching an unrecoverable upset condition. This time lapse also consumes valuable time in the period allotted for the pilots recognition that the autopilot is not functioning and that he must assume control of the aircraft. Any equipment which operates in this manner should also require the inclusion of operational warnings and any approved emergency procedures into the flight manual as a supplement.

Another area of concern is the requirements for a “positive disengagement” as they currently exist and as they are proposed. Both versions refer to a “positive disengagement” of the autopilot function and the location of the switches to be used for this disengagement.

The current approach of autopilot systems simply use a disengaging function either in the gearing mechanism or an engage clutch between the servo motor and the actual output of the assembly itself. Of course, this separates or isolates the servomechanism from the flight controls but leaves all the associated cabling, bellcranks, etc. attached to the primary flight control circuit. These additional items increase the complexity and therefore the opportunity for jams or restrictions in flight control movement.
When one executes a search of the existing service difficulty reports (SDR’s) in the FAA database, looking for entries which would indicate the lack of disengagement of a servo mechanism, a significant number appear. I therefore submit that the existing rules are inadequate and there should also be a positive disconnect implemented which would remove all autopilot associated hardware, cabling, etc. from the primary aircraft mechanical control circuits. This alone might preclude a significant loss of aircraft and lives as currently no option exists.

Another suggestion for inclusion in the new regulations would be the area of follow on certification requirements. When an applicant desires to certify an autopilot or FGS by similarity, there should be a requirement for additional flight testing to be performed at the four corners of the weight and balance envelope. The flight test data should then be provided to all interested parties, i.e., FAA and A/P or FGS manufacturer to determine the compatibility of the products. This flight test could also be expanded to include other critical phases of flight or conditions if so desired.

Another area which I would like to clarify is the previous version of the rule which states “within the range of adjustment available to the human pilot” in paragraph (f). This has always referred to the specific gains for each channel and their authority throughout the entire flight regime of the aircraft as certified. This is, and has always been, the only adjustment and its effects are available to the human pilot during the entire range of operation of the autopilot.

Last is the selection of English proposed to be used in the new ruling. My understanding of the current requirements are that the rules are to be written in “plain language” which I understand should be readable by all or at least most of the populace. The terms rare and normal are contradictory in themselves and intended to represent differing portions of a spectrum considered. When combined together as a term, they create significant confusion to a typical reader of English, who would not expect these terms to be combined in an effort to express a less than normal occurrence.

My dictionary provides the following meanings:

Normal: Conforming to a norm or standard; typical

Rare: Infrequently occurring; uncommon.

Why not simply state in plain English a “less than normal” occurrence and leave it at that. Of course, for the sake of being precise, one could assign a range of mathematical probabilities to the selected terms for clarity.

Sincerely,

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