

ENVELOPE PROTECTION (EP™)

The DFC90 system provides speed-based Envelope Protection (EP™) (underspeed and overspeed warnings and protection) when in any coupled autopilot mode.

NOTE

No Envelope Protection in Flight Director Mode

Envelope Protection (EP™) is not provided during flight director-only (non-coupled) operations.

NOTE

Aircraft Stall Possible with Envelope Protection

Conditions can exist where an aircraft can be placed in an attitude and/or configuration that would exceed the capability of the Envelope Protection (EP™) system to prevent a stall.

When the servos are engaged (AP mode), the likelihood that a command can be made which results in an autopilot induced stall is significantly reduced over conventional autopilots. If for example, a positive rate of climb was commanded and a low power setting is being held, the autopilot will attempt to achieve the commanded state but as the energy of the airplane decays to approximately $1.2 V_s$, the autopilot will adjust bank angle and then pitch angle as required to maintain no lower than $1.2 V_s$. Bank angle may be reduced before pitch is adjusted in an effort to avoid even entering Envelope Protection (EP™). As soon as bank angle is adjusted by the autopilot, the pilot is alerted through visual means on the PFD (a yellow “**UNDERSPEED**” text alert and any engaged (green) autopilot mode annunciator will flash) and as soon as pitch is adjusted, the pilot is alerted through the same visual means on the PFD, and aural alerting in the headsets (“SPEED PROTECTION ACTIVE”). In all cases, when underspeed protection is active, maximum bank angle will be reduced, typically to 5 degrees.

Similarly, Envelope Protection (EP™) will provide high-speed protection and alerting near V_{ne} . In this case, as V_{ne} is approached in AP mode, the autopilot will adjust pitch as required to maintain an airspeed near V_{ne} . Aircraft bank angle is not adjusted by the autopilot during overspeed protection. Depending on conditions (e.g. rapidly changing airspeed, turbulence, etc.), it is possible for V_{ne} to be exceeded. An overspeed condition is annunciated to the pilot via a yellow “**OVERSPEED**” text alert on the PFD, a “SPEED PROTECTION ACTIVE” aural alert in the headsets, and by a flashing of any engaged (green) autopilot mode annunciators.

The DFC90 is capable of taking flap position into account in Envelope Protection (EP™) and Envelope Alerting (EA™) calculations and as a result, the definition of V_s , changes depending on flap position in those aircraft with the flap wiring installed. The use of this flap input is part of Avidyne's Adaptive Autopilot™ concept.

NOTE

Envelope Protection During Icing Conditions

The DFC90 autopilot is not to be used during icing conditions. The autopilot does not have any kind of AOA or icing input and therefore does not register changing aircraft dynamics during icing conditions. Therefore, Envelope Protection (EP™) is not effective under icing conditions.

4 Approach Procedures

GENERAL BEHAVIOR

The integrated DFC90 and PFD system is designed to take full advantage of the auto transition capability of the GNS-430 units for flying a GPS flight plan ending in an ILS approach.

Note: For those aircraft that are not equipped with a 430-family GPS Nav-Com, the Aspen PFD converts the signals such that the DFC90 should behave in accordance with these descriptions. If the GPS or NAV does not support an input, the Aspen PFD sends the input as invalid to the DFC90.

Provided the GPS Nav-Com “ILS CDI Selection” is set to Auto, and VLOC was not manually selected by the pilot on the PFD Pri Nav line select key, at an appropriate time on the approach, the CDI course is automatically set to the inbound localizer course and the Pri Nav source is automatically toggled from GPS to VLOC resulting in a hands-free transition with the proper course dialed in the PFD Course setting. If the navigator either doesn’t have the capability or, hasn’t been set up to Auto toggle the ILS CDI selection, or VLOC was manually selected in the Avidyne PFD Pri Nav field, or AUTO CRS is disabled (Aspen PFD configurations) it is required that the inbound course be set using the PFD course set knob for accurate localizer intercept and tracking.

Note that “GS” mode as annunciated refers to a generic glideslope, encompassing both ILS glideslope and GPS WAAS approach vertical guidance.

Note that for all approaches except VORs, APPR mode will automatically arm when NAV is armed. VORs require the pilot to press the APPR button.

APPROACH MODES

WAAS APPROACHES

When “GPS1” or “GPS2” has been selected as the source in the “Primary Nav” LSK, and one of the GPS approach types with vertical guidance (LPV, L/VNAV, LNAV+V) is the selected approach, the ADI will provide horizontal and vertical guidance by means of the HDI (LDI on Aspen) and VDI.

WAAS approaches are intended to be flown in NAV APPR mode in the DFC90 system and thus the “Primary Nav” LSK must be set to GPS1/2. Roll commands are issued by the GPS Nav-Com in GPSS mode instead of the DFC90 and proper vertical guidance cannot be assured, hence the need to fly WAAS approaches in NAV APPR modes. Glide slope will not arm if the autopilot mode is GPSS.

If the autopilot were left in GPSS mode and the “Primary Nav” LSK is set to GPS1/2, then the autopilot will automatically switch from GPSS to NAV mode if/when a valid glide slope signal is received.

If the autopilot were left in GPSS mode and the “Primary Nav” LSK is set to VLOC1/2, then the glide slope will not arm and the autopilot will not automatically switch from GPSS to NAV mode.

There are several types of WAAS approaches:

LNAV (Lateral Navigation): Provides lateral (horizontal) guidance only, with standard GPS precision of 0.3 NM full-scale deflection. This is essentially the same as a non-WAAS GPS approach. It is flown as any other non-precision approach – descend to MDA, fly at MDA altitude to the MAP, and execute the missed approach procedure if appropriate.

For this approach type, a manual coupling to the autopilot is permitted. Prior to FAF the “NAV” (or “APPR”) button on AP must be pressed. There is no glide slope in a LNAV approach so a manual means to accomplish the vertical component of this approach needs to be enabled (VS and ALT). Then fly coupled to MDA.

LNAV+V (Lateral Navigation with Vertical Information)
This mode provides the same lateral navigation as LNAV, but presents an ILS GS-like presentation on the VDI. The GPS draws a 3-D picture of the approach based on crossing the FAF at the depicted altitude. Then it follows a glidepath from the published approach, which is typically a 3 degree angle to the touchdown zone. This type of approach remains a non-precision approach and does not consider any step-down limitations.

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to a wind-corrected heading until the station signal is re-acquired and signal tracking can resume.

For the condition when Nav mode is conducting its own 45 degree intercept, this is depicted by a cyan “NAV” autopilot mode annunciator indicating Nav mode is armed, followed by a green “45° INT” indicating the system is currently conducting a 45 degree intercept of the commanded Nav course. When the transition to captured course happens, the green “45° INT” extinguishes and in its place a green “NAV” is displayed.

NOTE

Approaches with Curved Paths Must Use GPSS

Certain GPS procedures involving curved paths can not be flown in NAV mode (e.g. holds, DME arcs, etc). GPSS mode must be used for those procedures.

GPS ROLL STEERING (GPSS) MODE

GPSS mode is entered by pressing the “GPSS” button on the autopilot control head. The system will light up the control panel button in green and track the lateral profile provided by the navigation source to the active GPS waypoint.

In GPSS mode, the roll steering-capable GPS Nav-Com is driving the intercept angle and subsequent course tracking. It is generally a more accurate intercept and tracking mode to be in than Nav mode. Roll commands are generated by the roll steering capable GPS Nav-Com system in GPSS mode.

If the Primary Nav LSK on the PFD is not set to a GPS source (GPS1 or GPS2), then the “GPSS” autopilot mode annunciator is lit in yellow indicating you have one source driving the CDI depiction and another source driving the autopilot.

If GPSS mode has been selected on the autopilot control head, and there is no active GPS waypoint, then “GPSS INVALID” is also depicted along the autopilot modes annunciator line of the PFD. The aircraft will continue in wings level, straight flight in this case.

GPSS INVALID

Failure Indication:

If the DFC-PFD system recognizes that the autopilot mode is GPSS but the roll steering information from the GPS Nav-Com is invalid, a yellow “**GPSS INVALID**” message is displayed on the PFD.

Functionality Lost:

Either a flight plan has not been entered in the governing GPS Nav-Com and GPSS mode was selected on the autopilot control head in which case, there is no loss of functionality, or the system is unable to fly the flight plan in GPSS roll steering due to some anomalous GPS Nav-Com situation or the ground speed is less than 40 knots.

Recommended Pilot Action:

Enter a flight plan into the navigator or select an autopilot mode that is not GPSS.