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Federal Aviation Administration

Memorandum

Date: June 8, 2009

To: Anne Graham, Acting Manager, General Aviation and Commercial Division, AFS-800

THRU: Michael J. Zenkovich, Acting Manager, Flight Standards Division, ASW-200

THRU: John S. Duncan, Manager, Air Transportation Division, AFS-200

From: Mark C. Fletcher, Manager, Fort Worth Aircraft Evaluation Group, FTW AEG

Prepared by: Edward L. Hinch, 817-222-5054

Subject: Bell 412 Chelton Flight Logic EFIS DisplayFlight Standardization Board (FSB)

The Flight Standardization Board for the Bell 412 Chelton Flight Logic EFIS Display completed its evaluation. Board members completed initial ground and flight training in the aircraft, and completed the areas of operation required by the Practical Test Standards for an Airline Transport Pilot rating.

Please post for comments and advise when concurrence is made.

Flight Standardization Board
Bell-412 Chelton Flight Logic EFIS Display
Transport Category

APPROVED: _____ 5-29-09
Edward L. Hinch, Chairman — DATE

CONCUR: _____ 6-4-09
Mark E. Fletcher, Manager — DATE
Fort Worth Aircraft Evaluation Group

CONCUR: _____
MANAGER, — DATE
Air Transportation Division AFS-200

CONCUR: _____ 8/26/09
MANAGER, — DATE
General Aviation & Commercial Division
AFS-800

BHT-412 CHELTON FLIGHT LOGIC EFIS DISPLAY
PART I

1. Purpose and applicability

The purpose of this report is to insure complete coverage and documentation of all Flight Standards responsibility regarding the supplemental type certification of the Chelton FlightLogic EFIS on the BHT-412. The BHT-412 aircraft is presently certificated Part 29 Transport Category A/B, and is approved for Day and Night VFR and IFR. This aircraft is capable of being utilized for scheduled Commuter Operations and On-demand Operations under Part 135, pilot training under Part 61, and Private carriage under Part 91. Other possible uses include operations under Part 137, and Part 133.

The Chelton FlightLogic EFIS is a complete flight and navigation instrumentation that provides information to the pilot via the Integrated Display Unit (IDU). The IDU can be configured as a Primary Flight Display (PFD), or a Multi-Function Display MFD). The PFD is a three-dimensional, enhanced situational awareness display that provides forward-looking terrain, attitude, altitude, airspeed, vertical speed, direction, and Highway-in-the-Sky navigation. The MFD can display a moving map, terrain, HSI or a combination thereof.

The Chelton FlightLogic EFIS has been certified to TSO C-146a Class Gamma 1 and complies with AC20-138A for navigation using GPS and WAAS (within the coverage of Space-based Augmentation system complying with ICAO Annex 10) for enroute, terminal area, and non-precision approach operations (including "GPS" or "GPS and RNAV" approaches. Allowable approach types include LNAV and LNAV with Barometric VNAV. Operation of this system is described below:

CHELTON EFIS AUTOPILOT INTERFACE

1.1 GOALS

One of the goals of the Chelton EFIS autopilot interface was to bring integrated FMS-style autopilot control to legacy autopilot systems in retrofit applications. With the integrated design, pilots can engage the autopilot immediately upon initial climb, and disengage just before landing. In most cases, all pilot inputs for autopilot control are done with the EFIS controls (including RBP) and there is no need for the pilot to change autopilot modes to perform most tasks. This is accomplished is described below:

1.2 LATERAL CONTROL

Lateral control operates through conventional HDG (commanded roll-based mode) and NAV/APPR/BC (course deviation-based modes) autopilot modes. For most operations, HDG mode is the preferred control methodology.

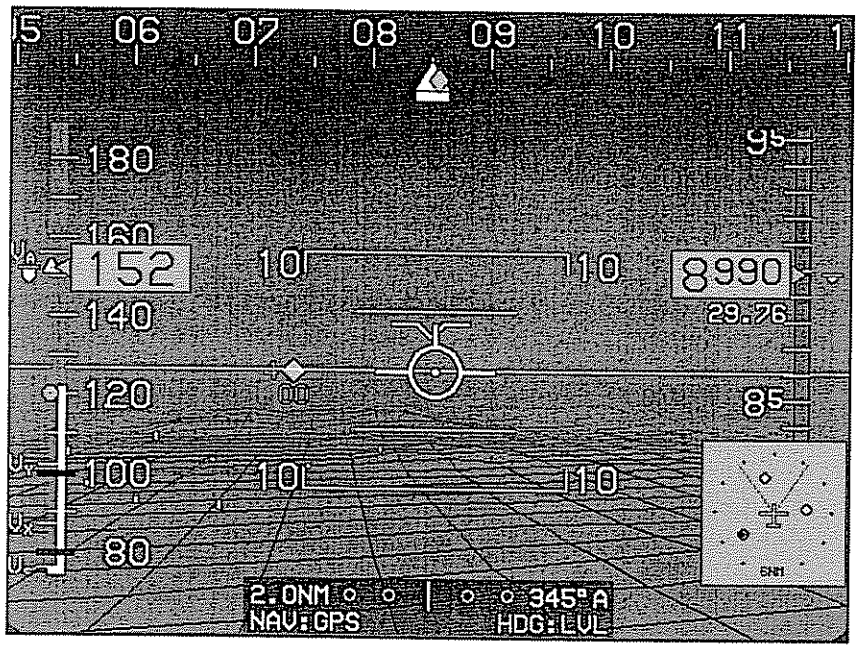
1.2.1 HDG ("Commanded Roll") MODE

1.2.1.1 Logic

This mode is often referred to as "EFIS-coupled" because in this mode, the EFIS directly controls the roll of the aircraft to achieve a desired result. In this mode, there are four sub-modes as follows:

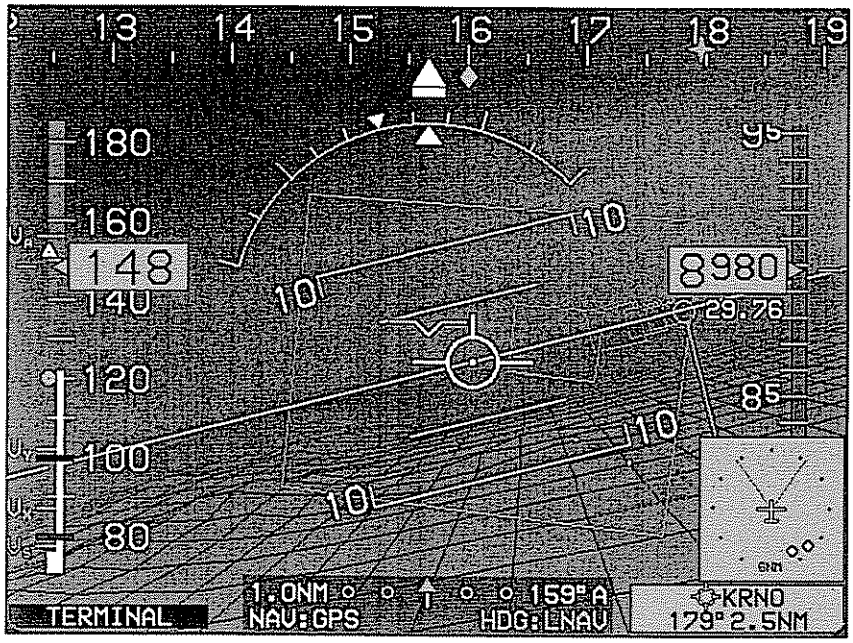
1.2.1.1.1 Wing-Leveling Sub-Mode:

This is the default sub-mode that is active when the heading bug is turned off and there is no active flight plan. This sub-mode requires valid attitude and heading. In this sub-mode, the system commands a roll of 0° to maintain level flight. The screen capture below shows this mode with positive feedback from the autopilot that the appropriate autopilot mode is engaged (green annunciation):



1.2.1.1.2 LNAV Sub-Mode:

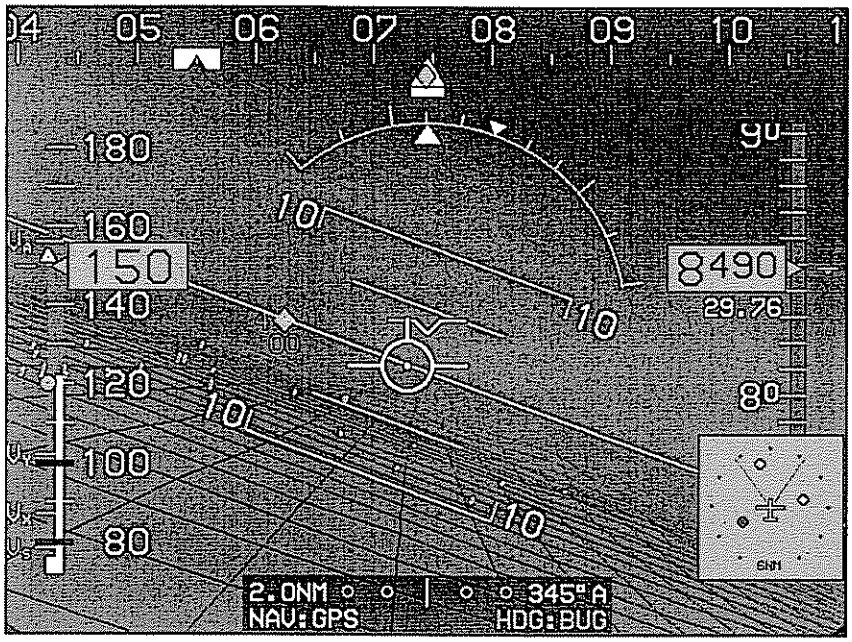
This sub-mode is active when an active flight plan exists and the heading bug is turned off. In this sub-mode, the system commands roll angles to intercept and track the active flight plan or manual GPS course. Commanded roll angle magnitude is limited to 25°. In addition, a 3°/sec roll rate limiter is built into this sub-mode. All parts of an active flight plan, including all ARINC-424 leg types, can be tracked including procedure turns, holding patterns with entry, arcs, search patterns, parallel offsets, etc. This sub-mode requires valid attitude, heading and air data (i.e., at least enough information to perform DR NAV in accordance with RTCA/DO-229C). The screen capture below shows this sub-mode with positive feedback from the autopilot that the appropriate autopilot mode is engaged (green annunciation):



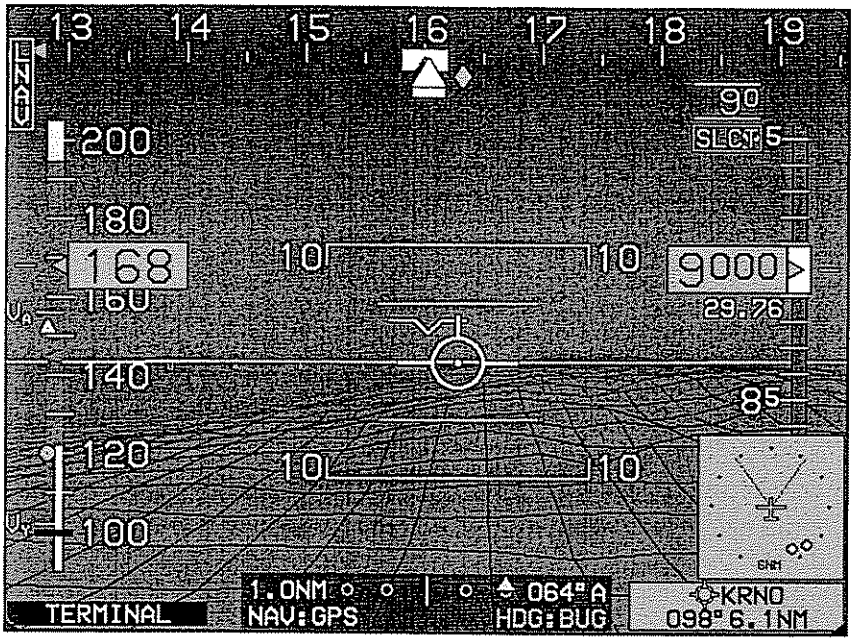
When intercepting the active flight plan or a manual course, the default intercept angle is 45°. The default intercept angle can be overridden using the heading bug to perform "all-angle" intercepts of up to 135°. See description of "all-angle" intercepts in the heading bug sub-mode description below.

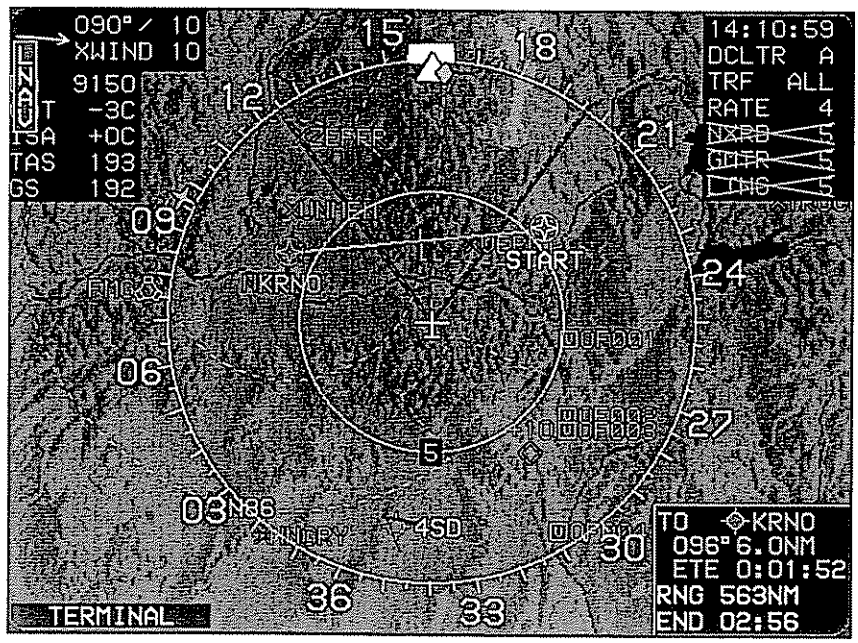
1.2.1.1.3 Heading Bug Sub-Mode:

This sub-mode is active when the heading bug is active and overrides all other sub-modes. In this sub-mode, the system commands roll angles to track the heading bug. To emulate the behavior of a conventional analog HSI, no limiting is used. This sub-mode requires valid attitude and heading. The screen capture below shows this mode with positive feedback from the autopilot that the appropriate autopilot mode is engaged (green annunciation):

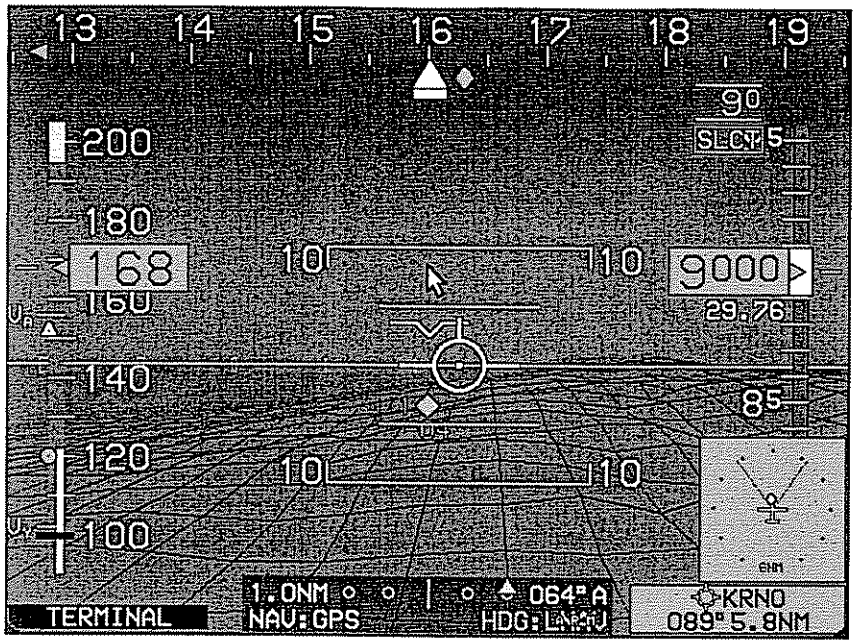


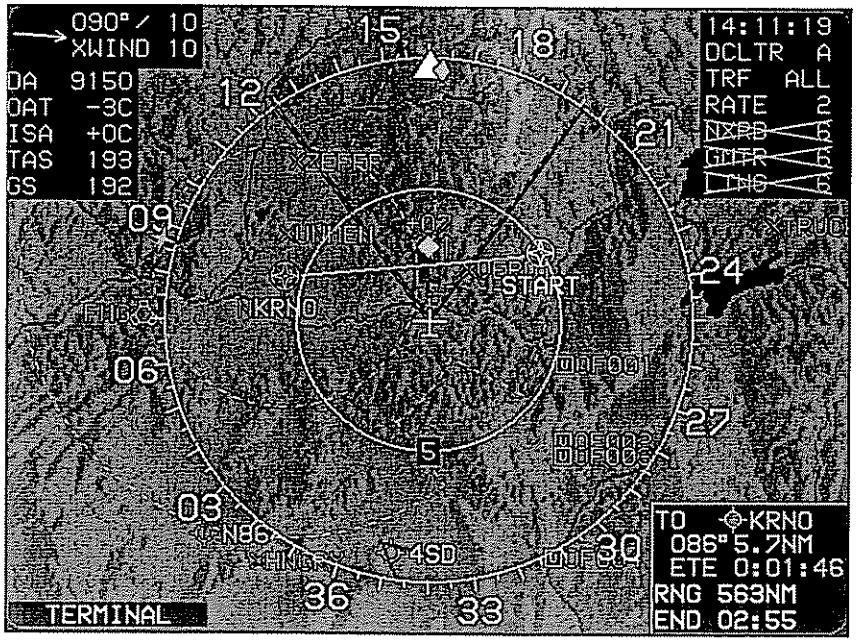
When an active flight plan exists, the heading bug can be used to manually set the intercept angle ("all-angle" intercept). Once the desired intercept heading is achieved, the "LNAV" menu tile is pushed to activate the LNAV sub-mode:



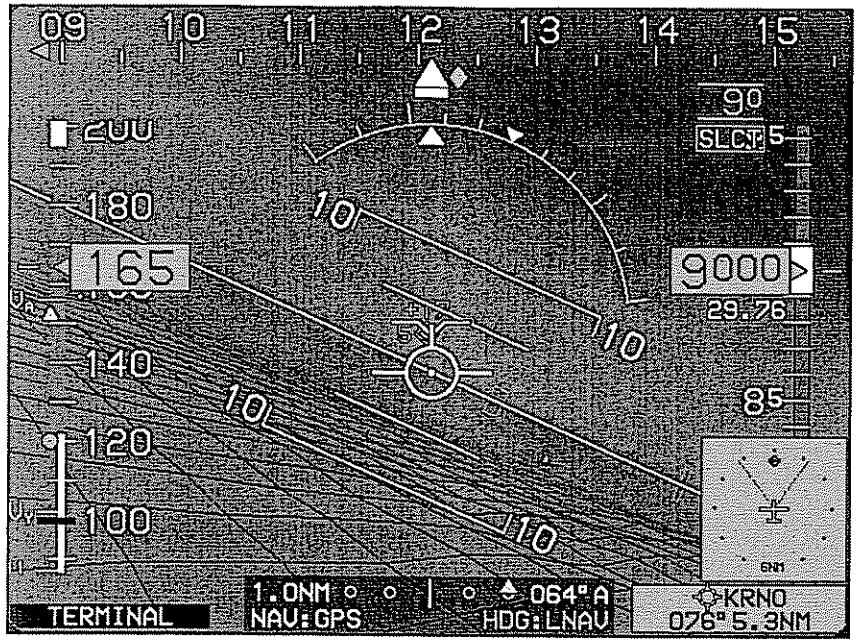


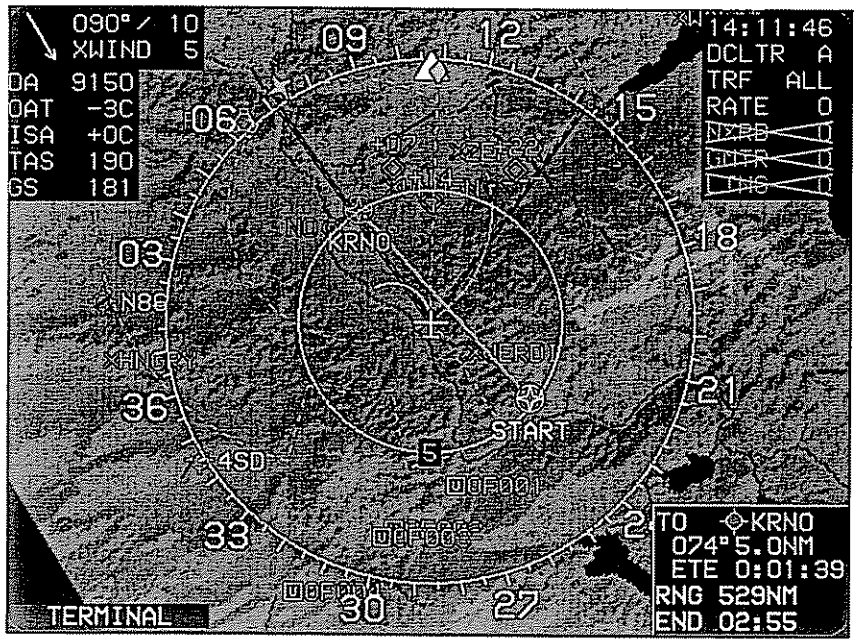
Once the LNAV sub-mode is activated, an "ARM" annunciation appears until the course intercept begins:





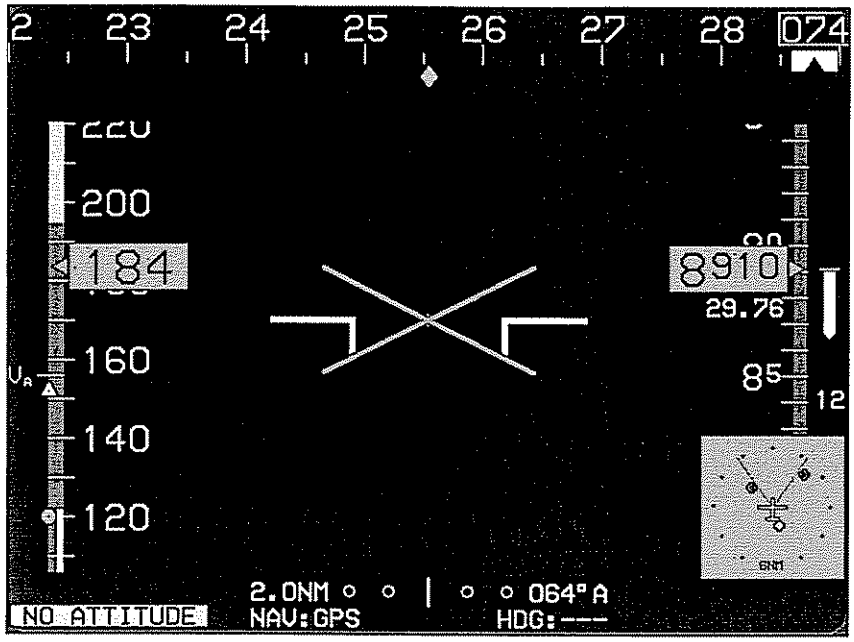
Once past the 45° point in the intercept, normal LNAV course tracking commences:





1.2.1.1.4 Failure Sub-Mode:

When a sensor failure precludes use of any of the above sub-modes, the HDG annunciation changes to dashes "---" as shown below:



1.2.1.2 Analog Outputs

The analog output for the heading mode is identical to the heading error/heading datum output of a conventional analog HSI. An Analog Interface Unit (AIU) is used to generate the output based upon digital EFIS commands. The AIU can be configured to output DC or AC outputs of a variety of voltages and frequencies to interface with most legacy analog autopilots. When a failure condition occurs that precludes a valid output, a signal that corresponds to 0° is sent. In addition, an EFIS discrete output can be configured as a valid flag to automatically disconnect the autopilot when in a failure condition. The EFIS discrete output takes into account failure conditions and AIU status.

1.2.1.3 ARINC-429 Outputs

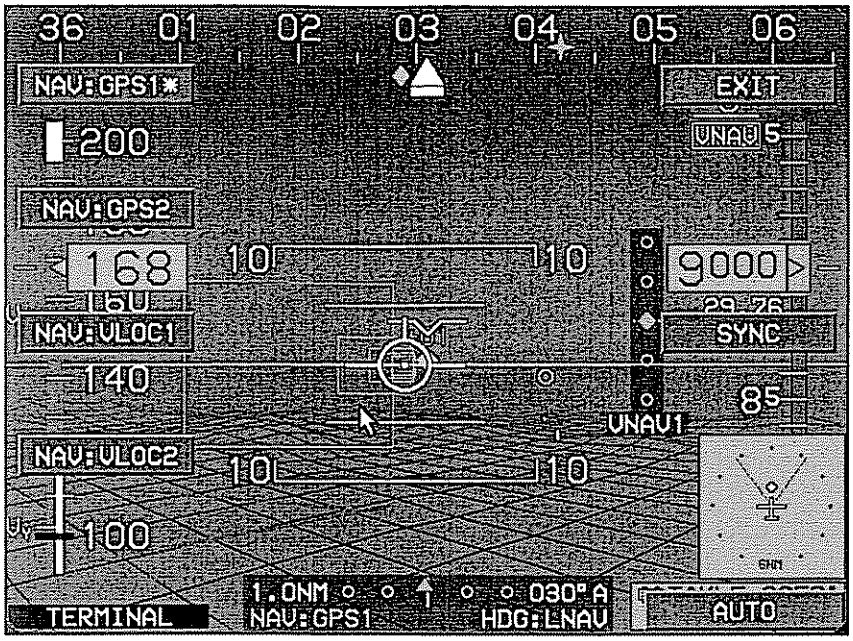
The heading mode drives the following ARINC-429 labels:

Label	Name	Notes
101	Selected Heading	Referenced to magnetic North
121	Horizontal Command Signal	Roll angle command. Output limited to 25°.

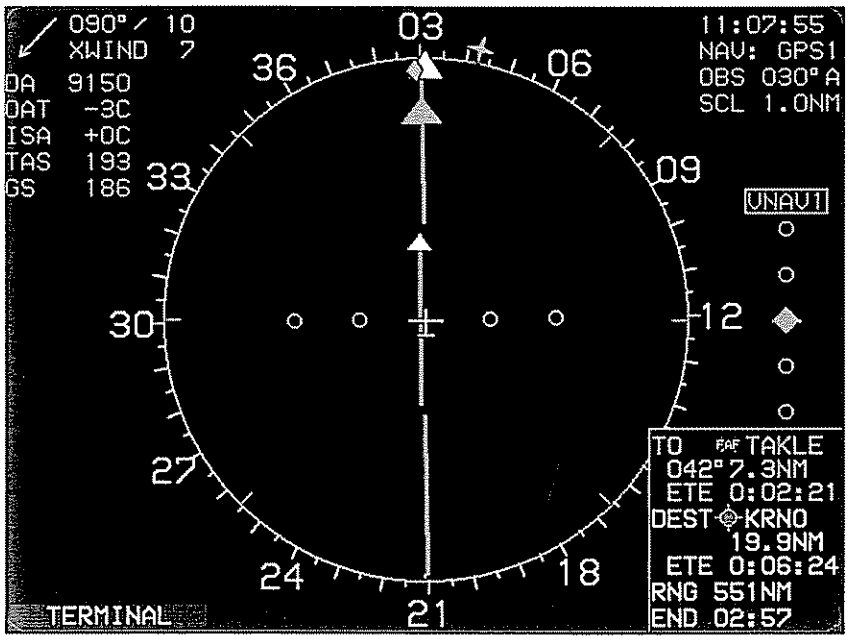
1.2.2 NAV MODE

1.2.2.1 Logic

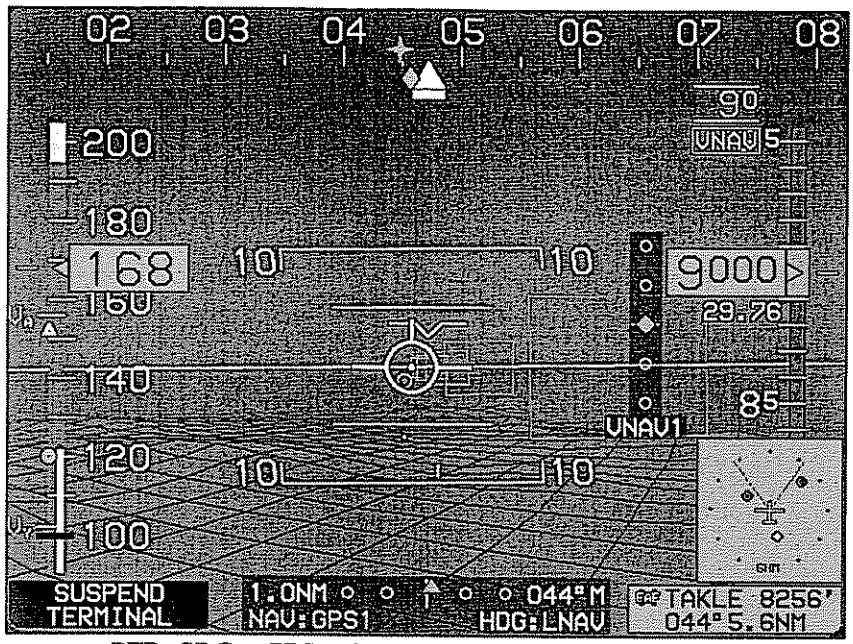
This mode outputs conventional course error/course datum and deviation signals to enable an autopilot to track a course in conventional NAV, LOC, APPR or BC modes. Signal source and associated course are selectable on the EFIS through the OBS menu function. Valid source selections are GPS1, GPS2, VLOC1 or VLOC2. With GPS1 or GPS2 selected, the course can be set manually or can automatically track the active flight plan (ref: RTCA/DO-229C). With VLOC1 or VLOC2 selected, the course must be set manually. Full scale deflection for the deviation signal depends upon the source. For GPS1 and GPS2, full scale deflection depends upon mode of flight (ref: RTCA/DO-229C). For VLOC1 and VLOC2, full scale deflection is angular (i.e., 10° if tuned to a VOR, 2 dots if tuned to a Localizer). Selected source, course, deviation and full scale deflection are indicated on the PFD CDI and on the MFD HSI page as shown below (note green annunciation meaning positive feedback from the autopilot that the appropriate autopilot mode is engaged):



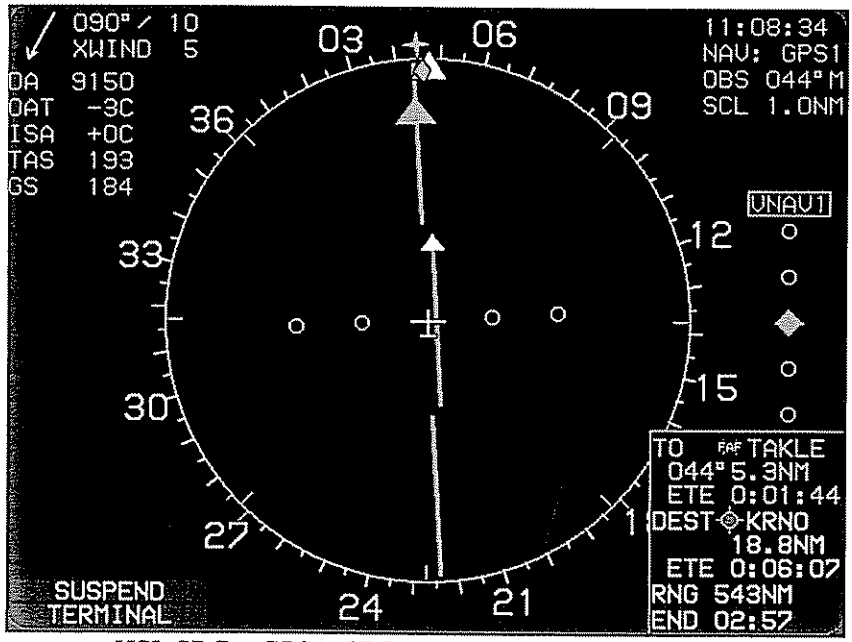
PFD: OBS Menu, SRC = GPS1, CRS = Auto, FSD = 1NM



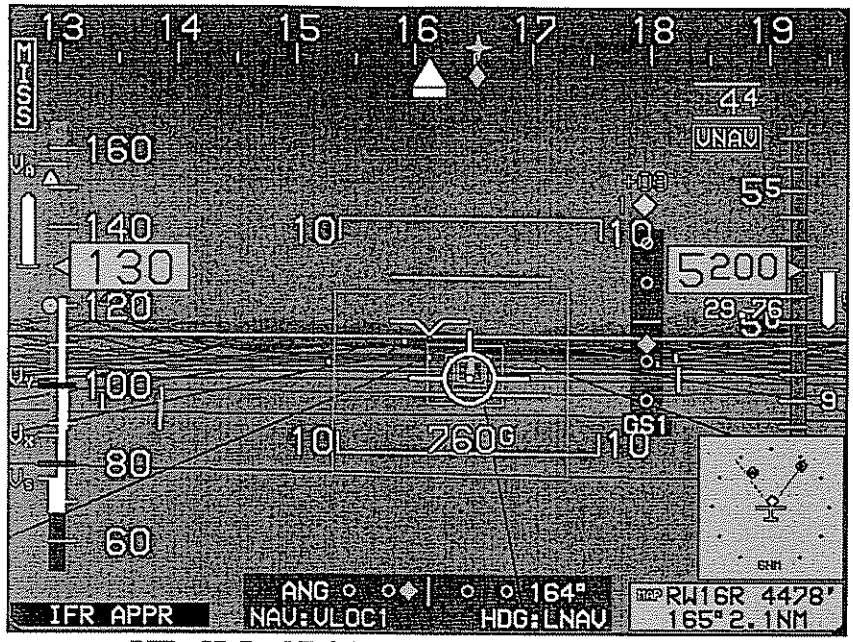
HSI: SRC = GPS1, CRS = Auto, FSD = 1NM



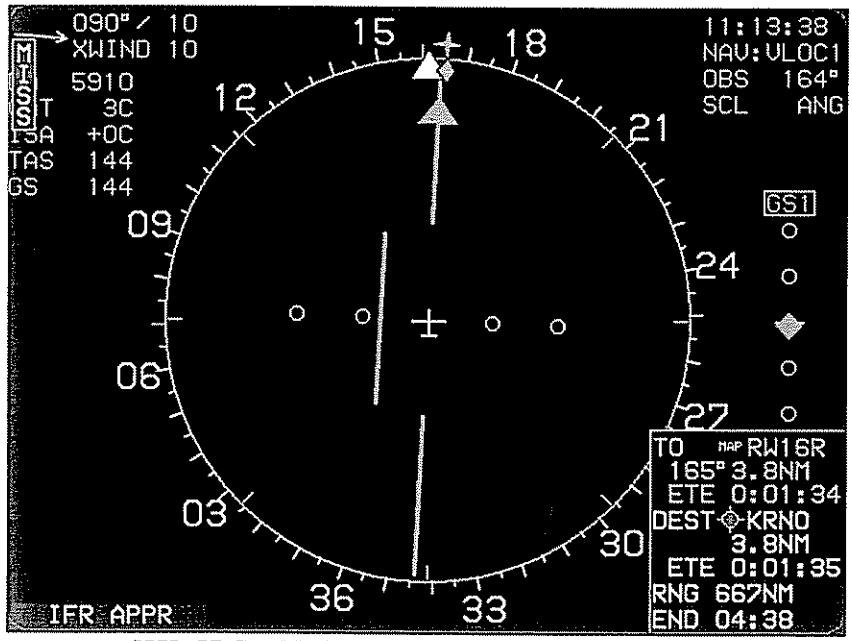
PFD: SRC = GPS1, CRS = Manual 044°, FSD = 1NM



HSI: SRC = GPS1, CRS = Manual 044°, FSD = 1NM



PFD: SRC = VLOC1, CRS = 164°, FSD = Angular



HSI: SRC = VLOC1, CRS = 164°, FSD = Angular

1.2.2.2 Analog Outputs

The analog outputs for the nav mode are identical to the course error/course datum, lateral deviation and nav valid flag outputs of a conventional analog HSI and NAV receiver. An Analog Interface Unit (AIU) is used to generate the outputs based upon digital EFIS commands. The AIU can be configured for a DC or AC course output of a variety of voltages and frequencies to

interface with most legacy analog autopilots. ±400mV DC deviation and open-collector/ground nav valid flag outputs are also provided. When a failure condition occurs that precludes a valid output, signals that correspond to 0° of course error and 0 lateral deviation are sent and the nav valid flag opens to indicate the invalid condition.

1.2.2.3 ARINC-429 Outputs

The nav mode drives the following ARINC-429 labels:

Label	Name	Nav Source	Notes
100	Selected Course	All	Course for selected Nav Source.
114	Desired Track – True	GPS1, GPS2	Manual OBS or active flight plan course
116G	Cross Track Distance	GPS1, GPS2	Cross Track Distance from Manual OBS or active flight plan course
326G	Lateral Scale Factor	GPS1, GPS2	Lateral scale factor depending upon GPS/WAAS navigation mode
173	Lateral Deviation	All	Lateral deviation for selected Nav Source.

1.3 VERTICAL CONTROL

Vertical control operates through a commanded pitch mode and GS/VNAV/APPR (vertical deviation-based modes) autopilot modes. For most operations, commanded pitch mode is the preferred control methodology.

1.3.1 COMMANDED PITCH MODE

1.3.1.1 Logic

This mode is often referred to as "EFIS-coupled" because in this mode, the EFIS directly controls the vertical performance of the aircraft to achieve a desired result. In addition, this mode features "envelope-protection" (ref: AC 25-15). On the low-speed end, pitch commands are limited so as to keep the aircraft above the higher of 1.2 x V_S, 1.2 x V_{REF}, or 60KIAS. Note that the low-speed envelope-protection is disabled below 1000'AGL to prevent undesired nose-overs as the aircraft slows for landing. On the high-speed end, pitch commands are limited so as to keep the aircraft below the lower of V_{NE}, V_{MO}, M_{MO}, or, if below 10,000'MSL, 250KIAS. Commanded pitch mode requires valid attitude, heading and air data. There are three commanded pitch sub-modes as follows:

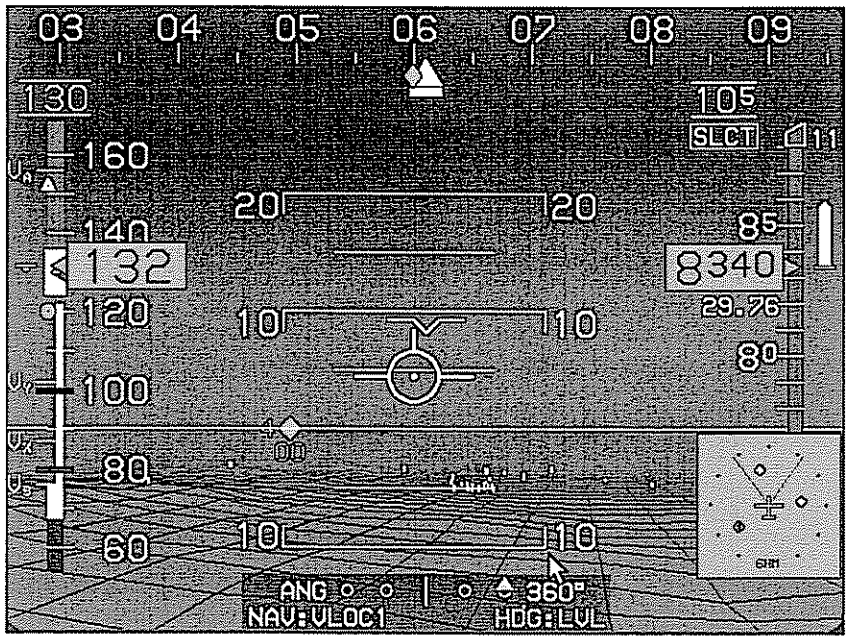
1.3.1.1.1 Level Flight Sub-Mode:

This is the default sub-mode that is active when there is no selected altitude and no VNAV altitudes associated with the active flight plan. In this sub-mode, the system commands level flight. No altitude annunciation is shown in this sub-mode.

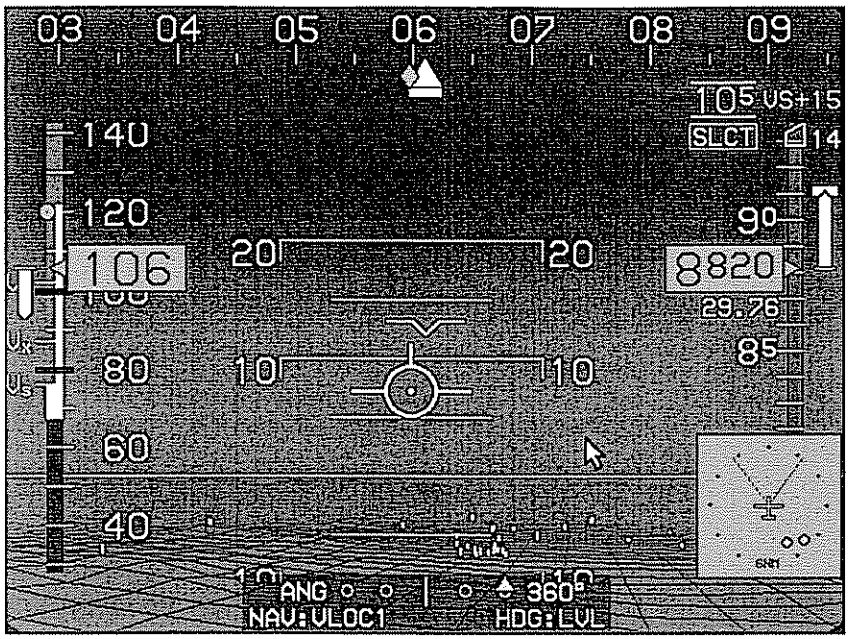
1.3.1.1.2 Selected Altitude Sub-Mode:

This sub-mode is active when the pilot manually selects an altitude. The intent of the selected altitude sub-mode is to give the pilot a mechanism to climb or descend "right now" as if being given an assigned altitude from air traffic control. It is analogous to the heading bug sub-mode of the heading lateral mode.

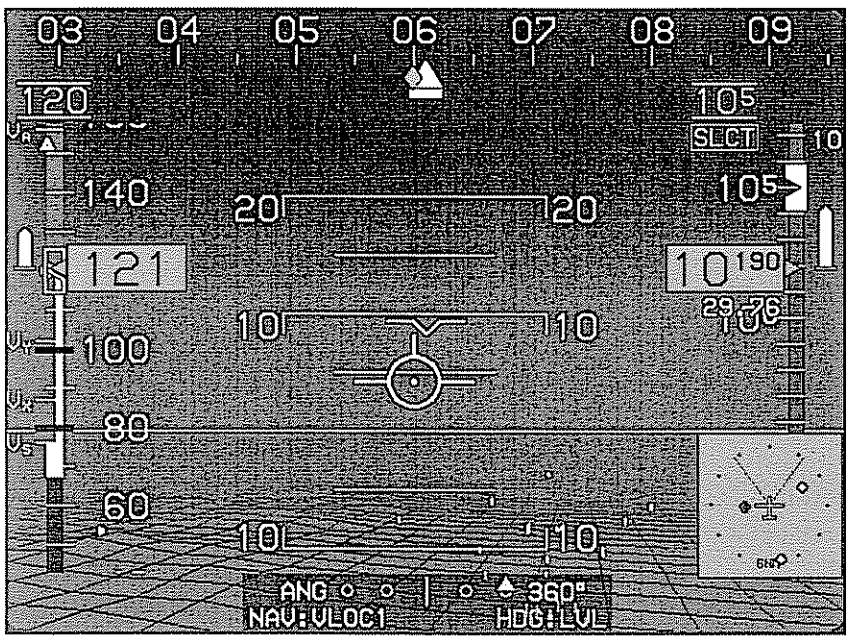
If the pilot activates a selected altitude above the current aircraft altitude, the system uses climb logic to achieve the selected altitude. In order of precedence, the climb logic will climb at: (a) the manually selected vertical speed or manually selected airspeed (note: these are mutually exclusive); or (c) the default climb airspeed/mach programmed into the system limitations. This is depicted in the following sequence (note green annunciations meaning positive feedback from the autopilot that the appropriate autopilot mode is engaged):



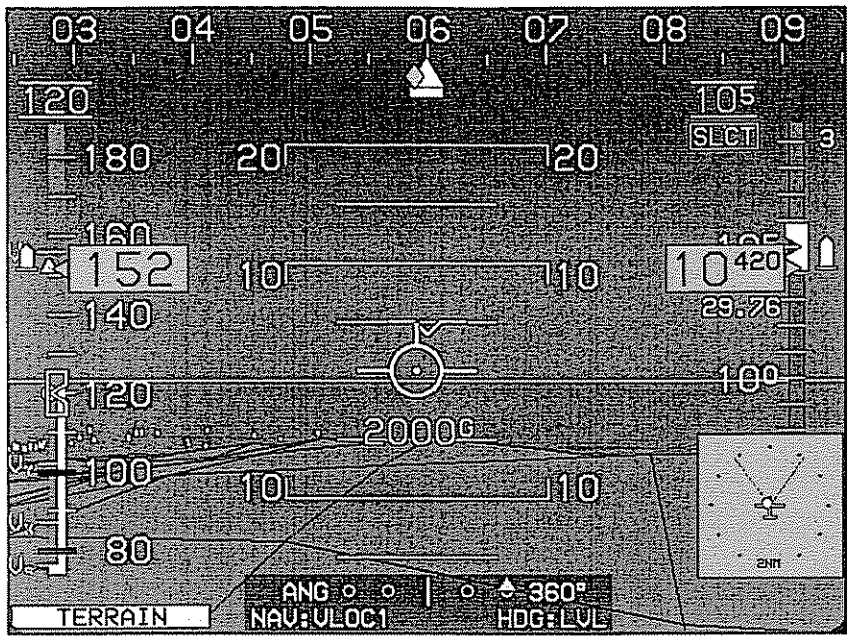
Airspeed Climb to 10,500'
Note selected airspeed is active (green color and filled bug)
Note altitude is pre-selected (white color and hollow bug)



Vertical Speed Climb to 10,500'
Note selected vertical speed is active (green color and filled bug)
Note altitude is pre-selected (white color and hollow bug)

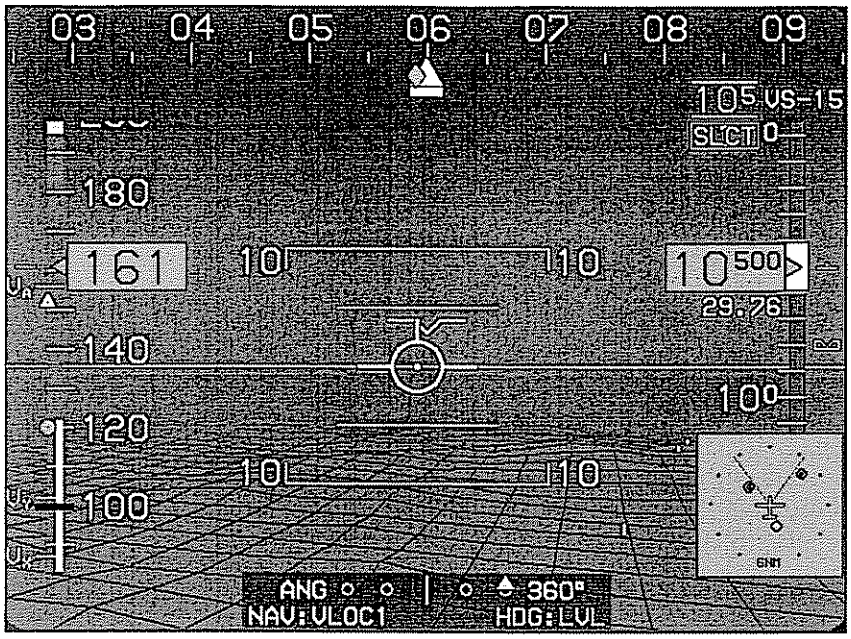


Commencing Altitude Capture from Airspeed Climb to 10,500'
Note selected airspeed is inactive (white color and hollow bug)
Note selected altitude is active (green color and filled bug)
Note that selected altitude display flashes during capture

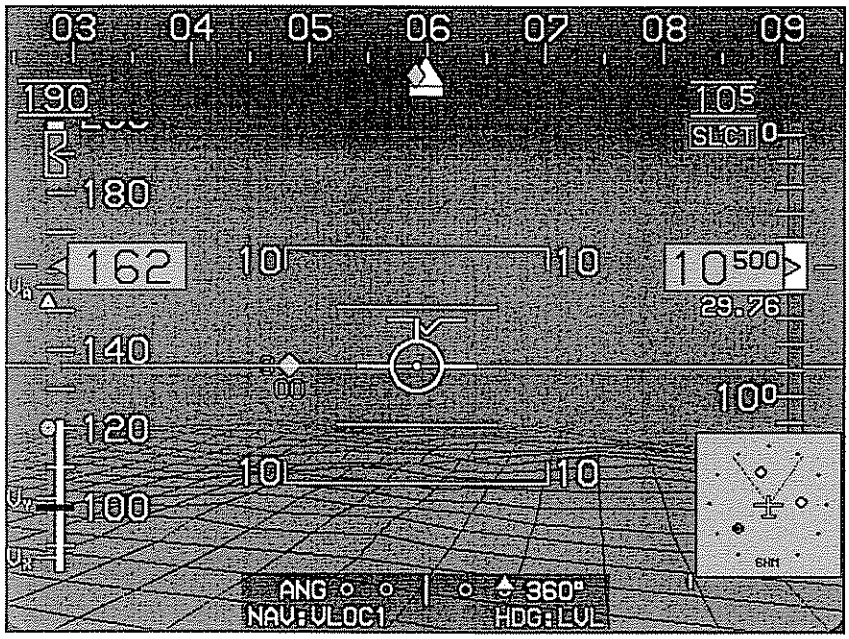


Altitude Captured (within 100') at 10,500'
Note selected airspeed is inactive (white color and hollow bug)
Note selected altitude is active (green color and filled bug)
After capture, selected altitude display is steady

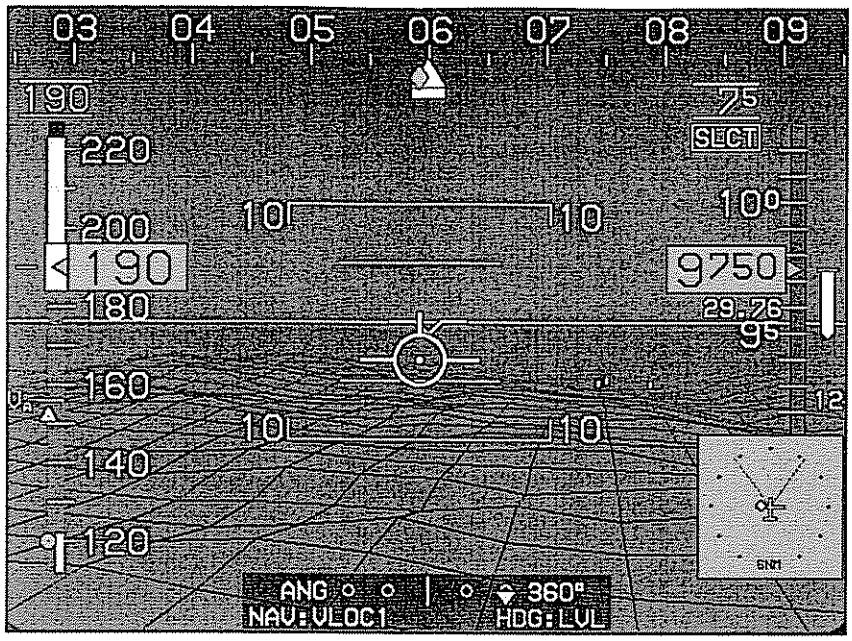
If the pilot activates a selected altitude below the current aircraft altitude, the system uses descent logic to achieve the selected altitude. In order of precedence, the descent logic will descend at: (a) the manually selected vertical speed or manually selected airspeed (note: these are mutually exclusive); or (c) a default descent airspeed that is set to current cruise speed + 20KIAS. This is depicted in the following sequence (note green annunciations meaning positive feedback from the autopilot that the appropriate autopilot mode is engaged):



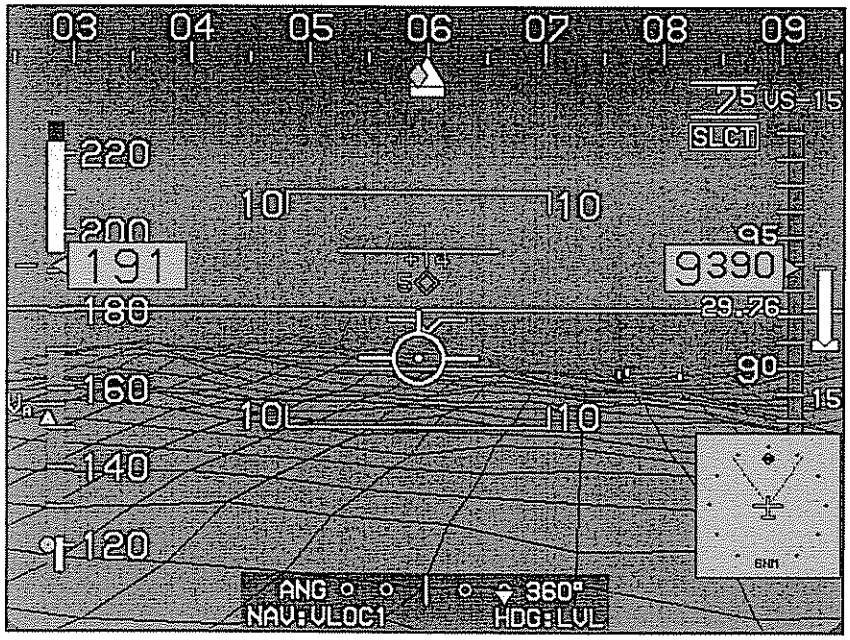
Altitude Captured at 10,500' with -1500FPM Pre-Selected Vertical Speed
Note selected altitude is active (green color and filled bug)
Note vertical speed is pre-selected (white color and hollow bug)



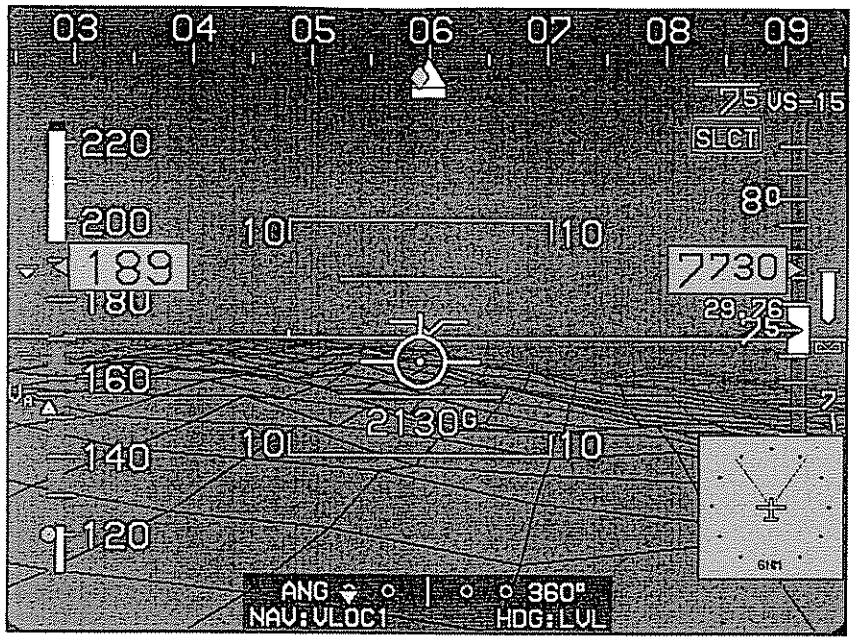
Altitude Captured at 10,500' with 190KIAS Pre-Selected Descent Speed
Note selected altitude is active (green color and filled bug)
Note speed is pre-selected (white color and hollow bug)



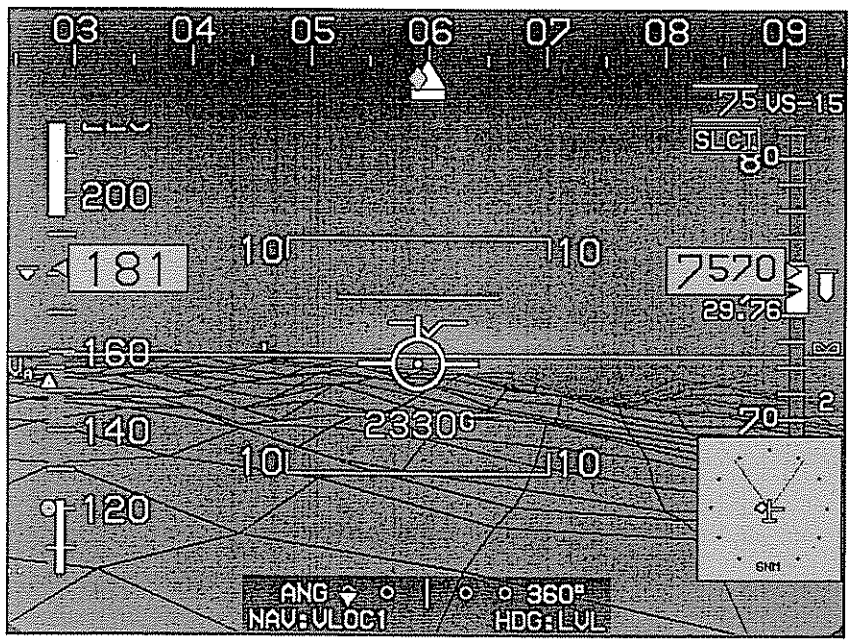
Airspeed Descent to 7,500'
Note selected airspeed is active (green color and filled bug)
Note altitude is pre-selected (white color and hollow bug)



Vertical Speed Descent to 7,500'
Note selected vertical speed is active (green color and filled bug)
Note altitude is pre-selected (white color and hollow bug)



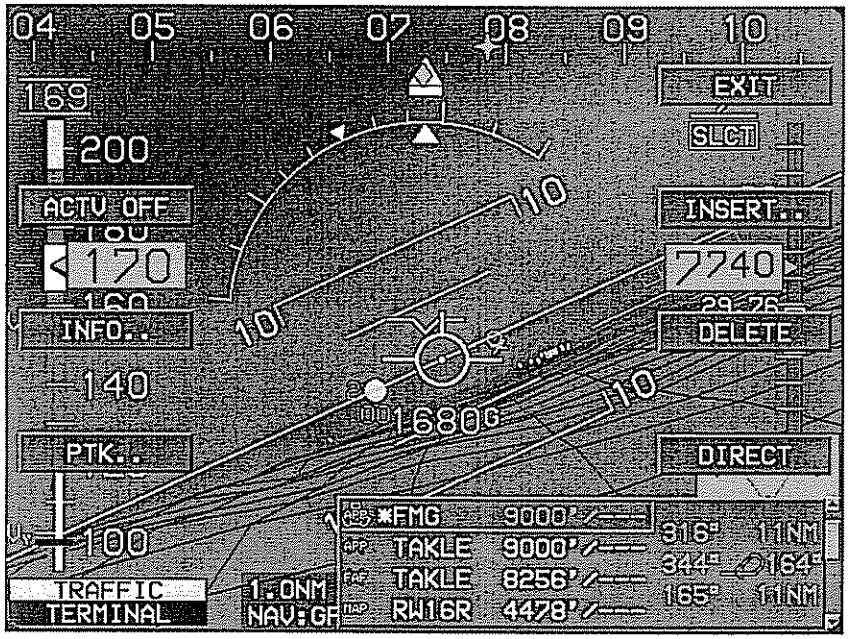
Commencing Altitude Capture from Vertical Speed Descent to 7,500'
Note selected vertical speed is inactive (white color and hollow bug)
Note selected altitude is active (green color and filled bug)
Note that selected altitude display flashes during capture



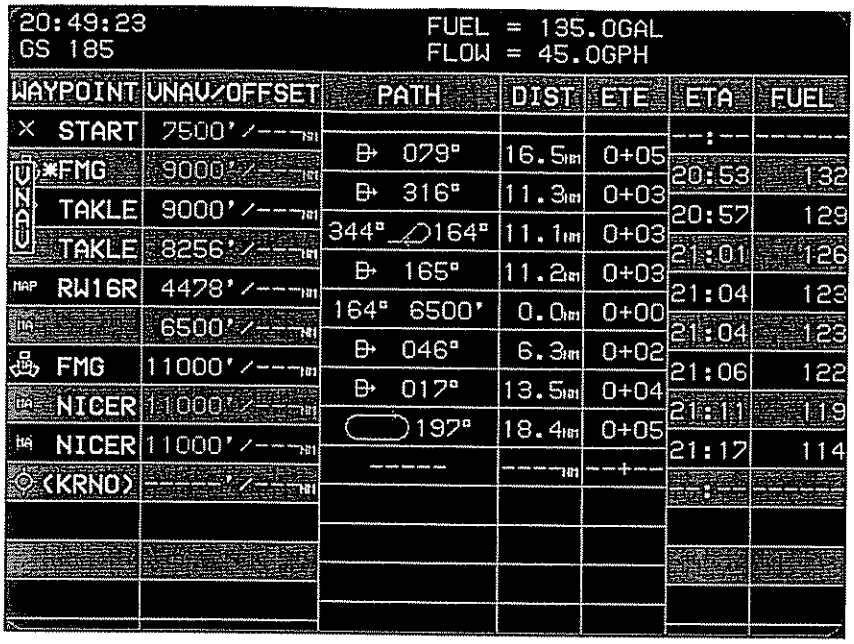
Altitude Captured (within 100') at 7,500'
Note selected vertical speed is inactive (white color and hollow bug)
Note selected altitude is active (green color and filled bug)
After capture, selected altitude display is steady

1.3.1.1.3 VNAV Sub-Mode:

This sub-mode is active when an active flight plan includes at least one VNAV altitude and the pilot has not manually selected an altitude. In addition, the LNAV deviation must be less than twice full scale deflection for the GPS/WAAS mode of flight and not operating in FROM mode for VNAV to operate. VNAV altitudes are imported from the navigation database in the case of instrument approach procedures ("IAPs"), departure procedures ("DPs") and standard terminal arrival procedures ("STARs"). VNAV altitudes and capture distance offsets can also be manually inserted into the active flight plan on a waypoint-by-waypoint basis. Database and manually inserted VNAV altitudes are readily identified in the active flight plan listing as white. Magenta-colored VNAV altitudes are calculated by the system to meet the VNAV constraints. This is depicted below:

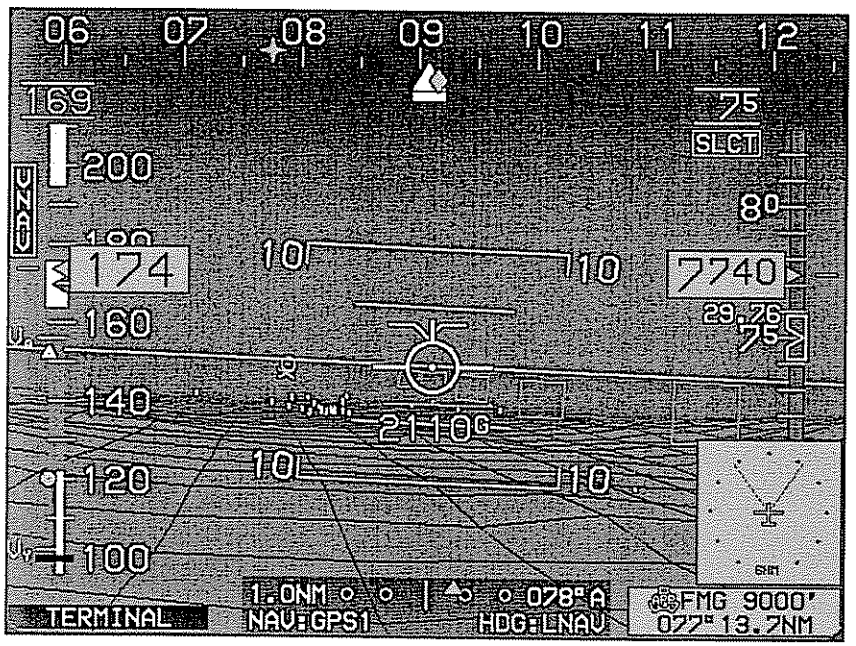


Active FPL Menu showing waypoint list with VNAV altitudes and offsets



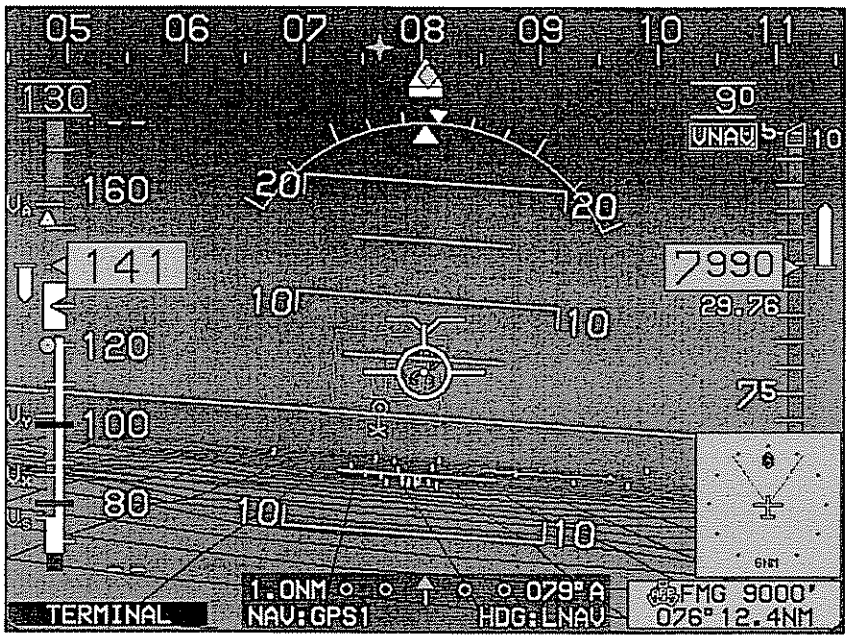
FMS page showing waypoint list with VNAV altitudes and offsets

When the system is capable of performing VNAV but the pilot has entered a manually selected altitude, a "VNAV" tile appears for one-touch engagement of VNAV.

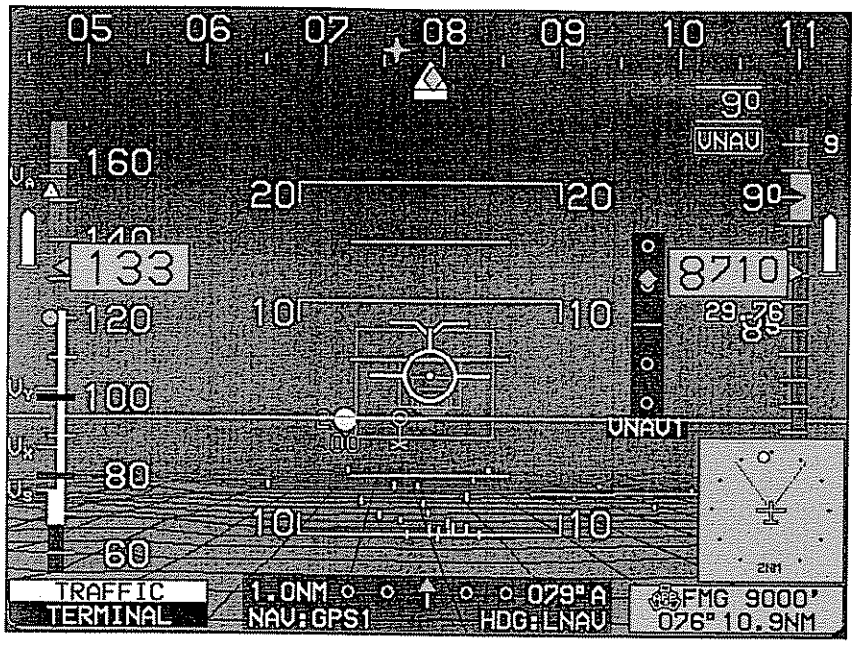


Once VNAV is engaged, the legend below the altitude target changes from "SLCT" to "VNAV" and the color of the bug symbol changes from white to magenta. In the VNAV sub-mode, the VNAV altitudes associated with the FROM waypoint and the TO waypoint are compared to determine whether to use climb, level flight, or descent logic.

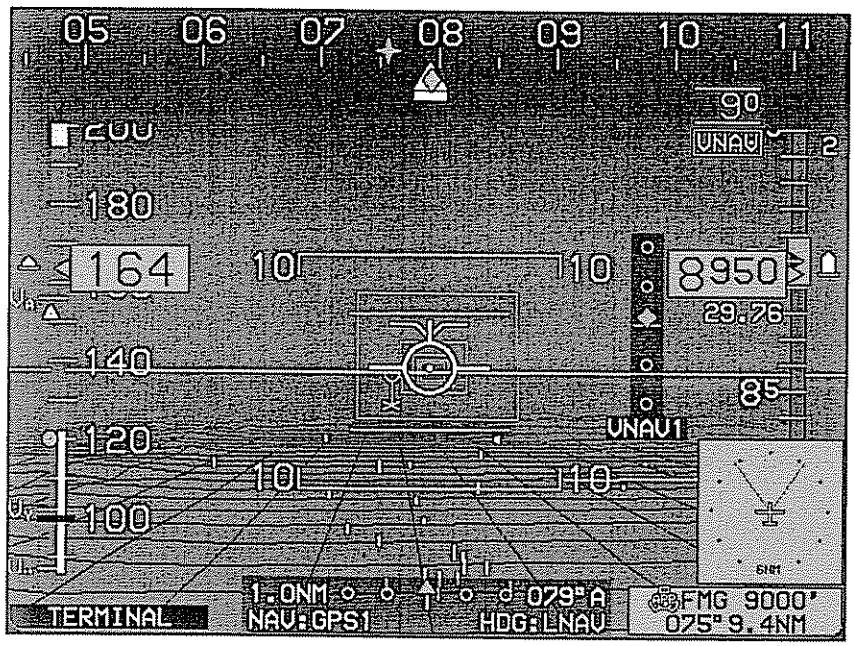
Control logic for climbs in the VNAV sub-mode is identical to that used for the selected altitude sub-mode, i.e., climbs are performance-based and do not follow a defined geographic profile (ref: RTCA/DO-236A and AC 20-129). As climbs in the VNAV sub-mode are not referenced to a geographic profile, no vertical deviation indication is shown. This is depicted in the sequence below:



Airspeed Climb to 9,000'
Note selected airspeed is active (green color and filled bug)
Note altitude is pre-selected (white color and hollow bug)



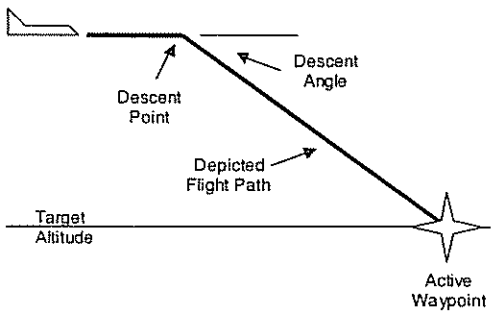
Commencing Altitude Capture from Airspeed Climb to 9,000'
Note lack of airspeed bug which means that the default climb speed was used
Note VNAV altitude is active (green color and filled bug)
Note that VNAV altitude display flashes during capture



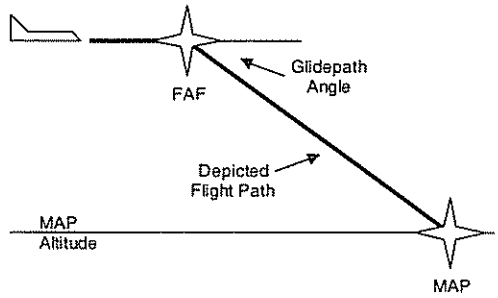
Altitude Captured (within 100') at 9,000'
Note VNAV altitude is active (green color and filled bug)
After capture, VNAV altitude display is steady
Vertical deviation appears during level flight segments

Descents in the VNAV sub-mode are based upon defined vertical angles emanating from a defined geographic point (ref: RTCA/DO-236A and AC 20-129). The defined geographic point used by the system is based upon the latitude and longitude of the waypoint including offsets. The vertical angle is pilot-defined on all legs with the exception of the final approach segment, in which the vertical angle is navigation database-defined. See below:

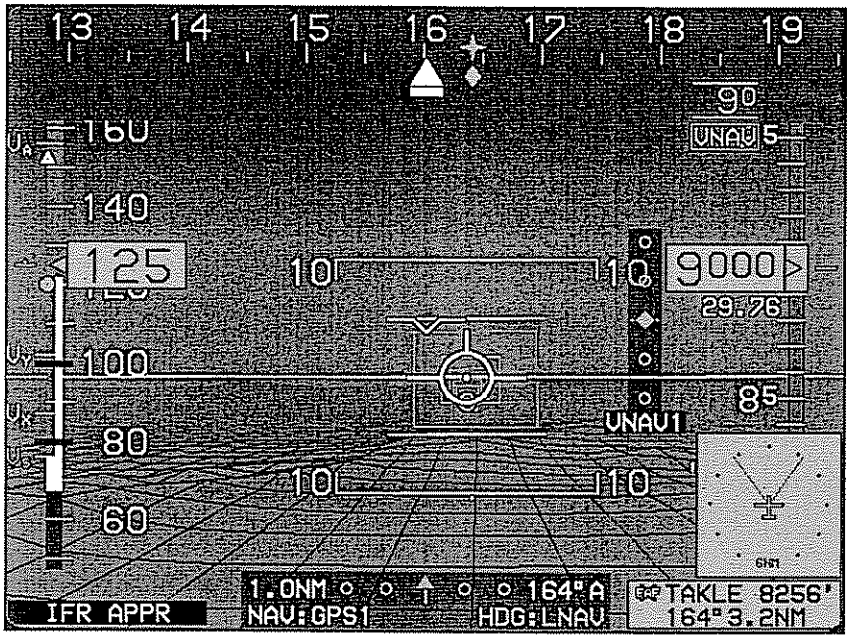
Normal Descent



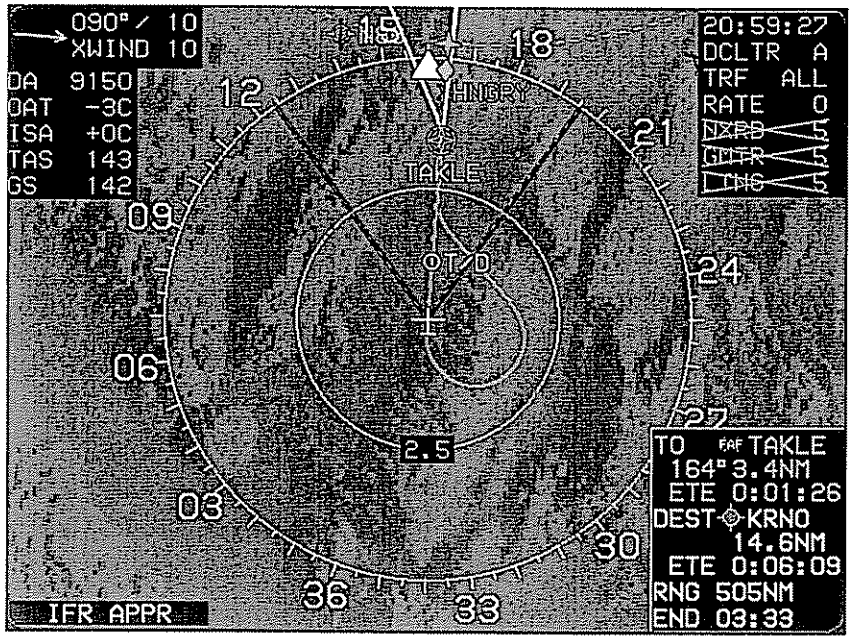
Final Approach Segment Descent



Prior to reaching the VNAV descent point, the pilot receives anticipatory cues on both the PFD and MFD Map. On the PFD, the highway in the sky can be observed commencing a descent. On the MFD Map, a "Top of Descent" symbol marks the descent point. See below:

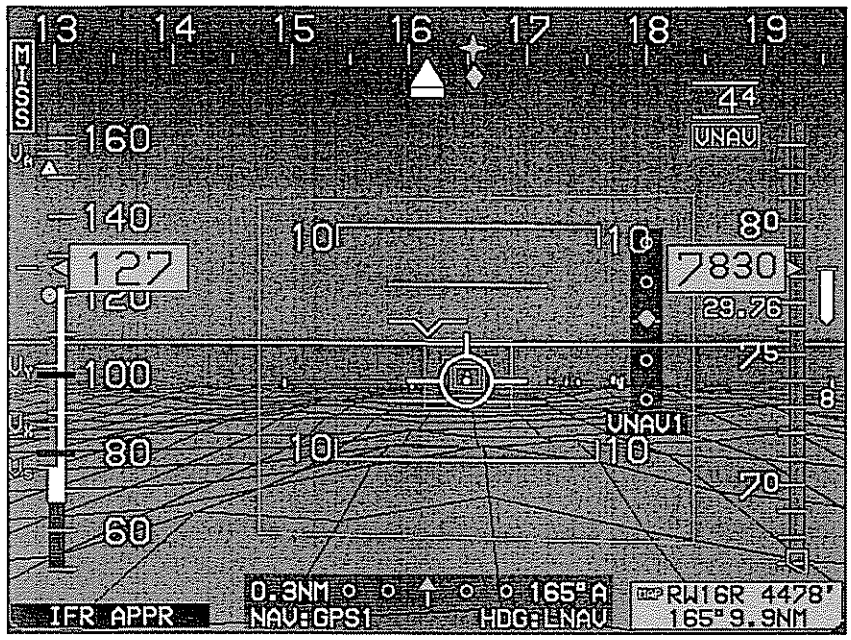


Highway in the Sky Anticipatory Cue for VNAV Descent



Top of Descent (T/D) Marking

During the VNAV descent, commands are given to track the path as shown below:



VNAV Path Tracking
Note VNAV path tracking is active (green "VNAV" annunciation)
Note VNAV altitude for active waypoint is pre-selected (white color and hollow bug)

1.3.1.2 Analog Outputs

Third party converters are used to transform ARINC-429 signals from the EFIS into analog signals useable by conventional analog autopilots. Typically, the altitude hold mode of the autopilot is used.

1.3.1.3 ARINC-429 Outputs

The commanded pitch mode drives the following ARINC-429 labels:

Label	Name	Notes
102	Selected Altitude	Either "SLCT" altitude or "VNAV" altitude depending upon sub-mode
103	Selected Airspeed	Airspeed used for climb
104	Selected VSI	Full-time VSI commands to track all profiles.
122	Vertical Command Signal	Full-time pitch commands to track all profiles.

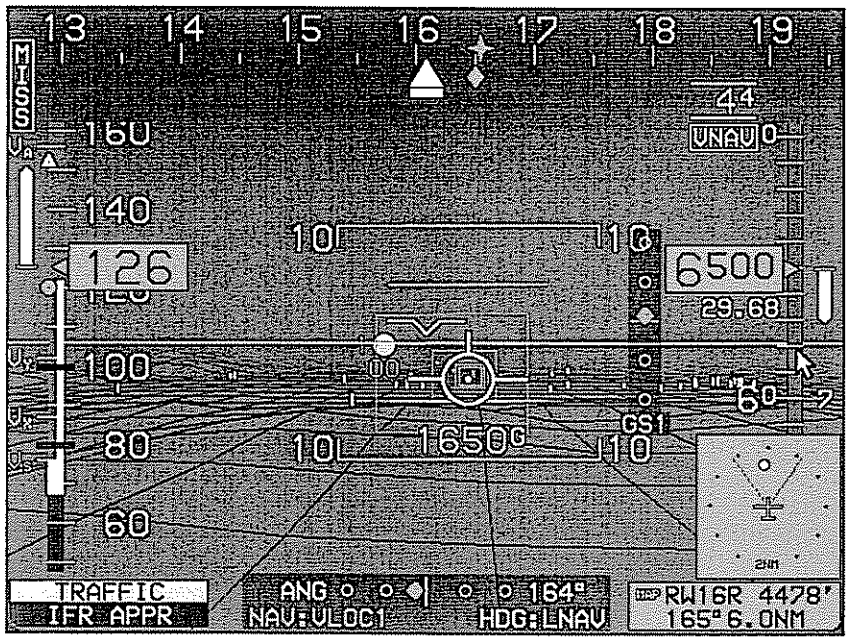
1.3.2 GS MODE

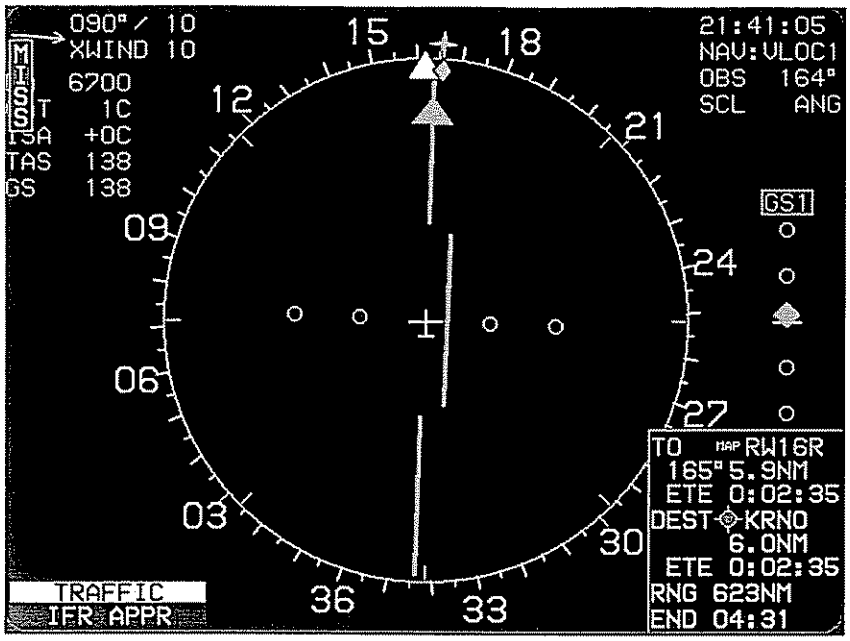
1.3.2.1 Logic

This mode outputs deviation signals to enable an autopilot to track a glideslope or VNAV path in conventional GS, VNAV or APPR modes. Signal source is selectable on the EFIS through the OBS menu. Source for the GS mode is linked to nav source as follows:

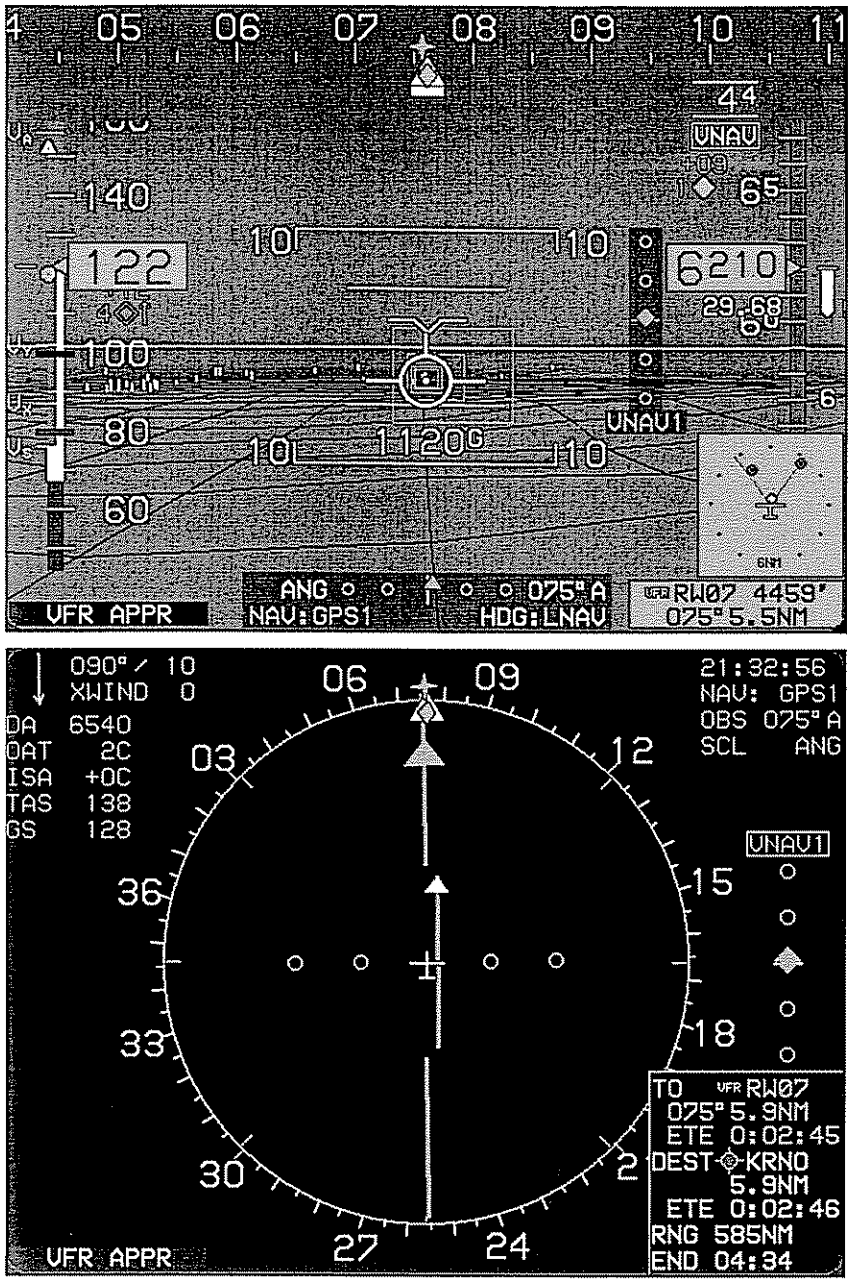
1. GPS1 → VNAV1 (Either barometric VNAV or GPS/WAAS VNAV when available)
2. GPS2 → VNAV2 (Either barometric VNAV or GPS/WAAS VNAV when available)
3. VLOC1 → GS1
4. VLOC2 → GS2

Full scale deflection for the deviation signal depends upon the source. For VNAV1 and VNAV2, full scale deflection depends upon mode of flight (ref: RTCA/DO-229C and AC 20-129). For GS1 and GS2, full scale deflection is angular (2 dots). Selected source and deviation are indicated on the PFD CDI and MFD HSI as shown below (note green annunciation meaning positive feedback from the autopilot that the appropriate autopilot mode is engaged):




090° / 10
XWIND 10
6700
T 1C
ISA +0C
TAS 138
GS 138
21:41:05
NAV:VLOC1
OBS 164°
SCL ANG
GS1
TO MAP RW16R
165° 5.9NM
ETE 0:02:35
DEST KRNO
6.0NM
ETE 0:02:35
RNG 623NM
END 04:31
TRAFFIC
IFR APPR
15
18
12
21
09
24
06
27
03
30
36
33

SRC = GS1



SRC = VNAV1

1.3.2.2 Analog Outputs

The analog outputs for the GS mode are identical to the glideslope deviation and valid flag outputs of a conventional NAV receiver. An Analog Interface Unit (AIU) is used to generate the outputs based upon digital EFIS commands. The AIU provides ±400mV DC deviation and open-collector/ground valid flag outputs. When a failure condition occurs that precludes a valid

output, signals that correspond to 0 vertical deviation are sent and the valid flag opens to indicate the invalid condition.

1.3.2.3 ARINC-429 Outputs

The GS mode drives the following ARINC-429 labels:

Label	Name	GS Source	Notes
117G	Vertical Deviation	VNAV1, VNAV2	Vertical deviation from VNAV path
174	Glideslope Deviation	All	Vertical deviation for selected GS Source.

2. **Pilot Type Rating Requirements**

The BHT-412SP is under 12,500 lbs gross weight, therefore does not require a Type rating. With the Chelton FlightLogic EFIS installed, type specific training in accordance with 14 CFR Part 61.31(h) is required.

3. Master Common Requirements (MCR's)

N/A

4. Master Differences Requirements (MDR's)

N/A

5. Acceptable Operator Difference requirements table

N/A

6. FSB Specifications for Training

Single and dual pilot IFR operations with this system installed requires the operator to complete a training program consisting of, as a **minimum,** the following :

a) 8 hours of ground school
b) 4 hours in static aircraft
c) Minimum of 5 hours flight (must demonstrate proficiency)

The course outline below, developed by Cobham Avionics Integrated Systems Synthetic Vision FlightLogic EFIS, entitled Technically Advanced Aircraft transition Training Syllabus should be used as a guide in conducting the required training.

Cobham Avionics Integrated Systems
Synthetic Vision FlightLogic EFIS

Technically Advanced Aircraft transition Training Syllabus

Course Outline

Developed in accordance with **FITS Curriculum Acceptance Criteria**

DAY 1

Estimated time to Complete: 8hours 30 minutes

OBJECTIVE- After completing the itinerary for Day 1 training, the pilot should have a general understanding of common terms, abbreviations, system operation and begin to develop a "flow" through the EFIS menus and functions.

NOTE- The instructor actions listed are set forth as a guideline and should be considered a minimum. Also, at the discretion of the instructor, training may be accelerated based on the ability of the pilot.

Review course pre-requisite training on risk management. Determine proficiency of student in addressing risk mitigation using industry accepted methodology.

GROUND SCHOOL OUTLINE:

Allotted Time: 5 hours

- ☐ **Acronyms & Abbreviations and their meanings** (pg 2-7 through 2-9)

TIME: 35min

- **Instructor Actions-** Explain to pilots the basics. One of the biggest barriers to effective instruction is failure to communicate with a common language.

- ☐ **What is going on *behind* the scenes?** (pg 2-27 though 2-34)

TIME: 20min

- Attitude/Heading Reference System (AHRS)
- Air Data Computer (ADC)
- GPS/WAAS Receiver
- WX-500(optional)
- TCAD/TCAS (optional)

- **Instructor Actions**- Explain to pilots the importance of understanding the equipment, the principles of operation, and their associated limitations

- ☐ **Resource materials -**

TIME: 20min

Instructor will refer the student to www.faasafety.gov for printed information on risk management concepts, risk management decision path and useful checklists for flight preparation.

- **Instructor materials -** Block diagrams from **Instructor toolkit. Course materials from King Schools Risk Management. Web based voice warning and master caution training course.**

FITS curriculum criteria checklist – SBT, SRM, Learner centered grading. (note: SRM will be included into every phase of every scenario)

Instructor shall be familiar with FITS tenets as applied to scenario based instruction.

NOTE- For the following items, training may be accomplished either on a desktop or aircraft installed IDU in Demonstrator/Training Mode.

- ☐ **Introduction to the Primary Flight Display-PFD** (pg 3-2 through 3-70 & 4-1

through 4-33) *TIME: 60min*

▪**Instructor Actions**- Cover ALL symbols and colors top to bottom and their meanings. Also, at this time, basic **VFR** functions such as setting an altimeter setting and a target altitude should be taught to the pilot. Explain the pilot where specific information is derived from. For example, the airspeed is delivered from the ADC. Also, insure that the pilot is familiar with, and has a ***clear*** definition of the flight path marker and how to appropriately use it. Use each one of the nine buttons (including enter) and relate them to specific times of use in-flight. While it may seem redundant, an in-depth knowledge of ***all*** buttons will lead pilots to decisive key presses and eliminate guessing, therefore less frustration. Also, feel free to elaborate on specific functions within a key press such as the "Zoom On" feature within Menu. Keep track of specific likes and dislikes of functions within the PFD and help the pilot use the Declutter(DCLTR) function as desired on their airplane..

□ **Introduction to the Multi-Function Display-MFD** (pg 3-71 through 3-128)
TIME: 60min

▪**Instructor Actions**- Again, cover all symbols and their associated colors top to bottom and their meanings. Explain key presses to activate functions such as a heading bug or a timer. Bring up different displays such as the traffic and lightning display and functions such as the HSI. This would be the appropriate time to explain two of the most used functions: the heading bug and the map scale. While the heading bug can be accessed from either the PFD or MFD, the "bug" is in view through 360° on the MFD and is more similar to the use of a heading bug on a conventional HSI. The map scale should be a function used throughout an everyday flight to scale out to view an entire procedure or route, and then scale in to a more precise course view. In the event the skyway boxes cannot be seen on the PFD, where are they and how do we find them? Answer: along the magenta course line depicted on the MFD. Use the MFD to determine an appropriate intercept heading to fly to join up with the HITS.

□ **Terrain, TAWS & GPWS** (pg 3-60 through 3-64 & Appendix 8-11 through 8-39)
TIME: 30min

▪**Instructor Actions**- The amount of information concerning TAWS can be overwhelming. Ensure that the pilot knows how to appropriately use the PFD and MFD in terrain proximity situations. Explain the different GPWS modes as described in the appendix and use the Demonstrator/Training Mode to illustrate sample situations. Have the student complete the online

training for master caution voice warning system.

□ Traffic (pg 3-66 through 3-67)

TIME: 30min

▪**Instructor Actions-** Review the equipment installed on the aircraft. Some installations use a separate display to display traffic (ex. MX-20), some use the Chelton IDU's and some use more than one screen to display traffic. Also find out what TCAD device is driving the traffic display (ex. RYAN TCAD). Make sure that the pilot understands the difference in traffic symbols and the automatic processes that the PFD and MFD will perform in the event of a traffic alert. For example, the Mini traffic display will automatically "pop up" on the PFD to aide in situational awareness in the event manual declutter has been selected by the pilot.

□ Aircraft Preflight and Preflight Discussion

TIME: 35min

▪**Instructor Actions**- At this time, spend a few minutes to discuss the plan for the flights. Use the Flight Training Outline below as a guide. Look at the LIMITS file using a smart media card to gain access to the ground maintenance functions. Take note of speeds such as VPROC. Explain how VPROC (procedure speed) is used to compute course lines when procedures are being flown. Explain GPS loss of integrity issues and how FDE and RAIM differ.

□ Overview discussion of Risk Management

TIME: 40min

▪**Instructor Actions**- Introduce the PAVE checklist for risk identification. Introduce the **TEAM checklist** for risk reduction. Introduce "what if" scenarios into the discussion to illustrate application of the individual items. Orally quiz the student to determine understanding of transfer, elimination, acceptance and mitigation of identified risks.

▪**Instructor materials-** Ground powered IDU in training mode. Screen shot photos from **Instructor toolkit, TEAM checklist. Decision Path worksheet: 3P Model. CARE checklist.**

Optional resource: ATC Traffic Flow Management tutorial. www.fly.faa.gov.

FITS curriculum criteria checklist – SBT, SRM, Learner centered grading.

(note: Learner centered grading is progressive. During each lesson, the learner should achieve a higher level of learning. By the end of the dual flights outlined below, the learner will have progressed through explanation, practice and manage-decide levels of learning.

FLIGHT TRAINING OUTLINE:

Allotted Time: 3 hours 30 minutes

NOTE- Two flights to be accomplished with discussion time between for debrief.

□ Local Dual Flight #1

FLIGHT TIME: 1.5 hours

▪**Instructor Actions**- If possible, fly to a less dense traffic environment to allow for more focus on introductory training. Discuss the dates applicable to NAV data contained in the startup screen and validate the currency of this data. Have the pilot use the nearest function to bring up the departure airport, followed by the INFO function to bring up the airport information such as frequencies and elevations. The instructor should communicate on the radios and allow the pilot to fly the airplane and begin to absorb information being presented. First flight training should involve flying to other airports in the vicinity in VFR conditions and loading VFR approaches to those airports. Discuss hazards involved with guidance under FMS VFR skyway box flying. Introduction of autopilot integration and GPSS/roll steering methods should be demonstrated. **While in VFR conditions,** place the aircraft in different terrain proximity situations and allow the pilot to use the PFD and MFD to safely and appropriately navigate away from the terrain threat (AT NO TIME SHOULD THE AIRCRAFT BE PLACED IN A SITUATION THAT WOULD JEOPARDIZE THE SAFETY OF THE FLIGHT). If traffic is presented on the PFD and MFD, have the pilot decode the traffic symbol and begin to develop a relationship between the "outside picture" and the PFD for visually locating traffic. Autopilots are traditionally broken down into lateral navigation and vertical navigation. *Usually* the only inputs to the vertical channel of the autopilot are the glide slope from and ILS receiver, the pitch wheel on the autopilot control panel and the altitude hold function itself. At this time, the vertical channel output from the EFIS has been disabled. So while capable of lateral navigation, the EFIS is not capable of driving the vertical channel of the autopilot. Use the autopilot in Heading Mode and then use both the heading bug and lack of the heading bug to illustrate how the EFIS outputs to the autopilot. Introduce tracking to and from a VOR, NDB and ILS facility using both the PFD displayed HSI and the HITS guidance from WAAS GPS. Using a view limiting device such as foggles at this time is at the combined discretion of the pilot and instructor.

□ Local Dual Flight #1 Postflight Discussion & DAY 1 Debrief

TIME: 30 min ▪**Instructor Actions**- Ensure that throughout the course of the flight you take detailed notes of behaviors and repeated errors made by the pilot and inform them of these to allow for correction. At this time, ensure that all student questions are answered. Review identified risks and actions taken. Discuss **the 3P model** in the decision path. Ie. Perceive, Process, And Perform.

Learner Actions- To facilitate learner centered grading, the student will complete an evaluation of the dual flight. A percentage score will be self assigned using 70% as the passing level. Achievement of 85% is the desired goal before proceeding to each

next step of training. After self evaluation, the learner shall consult with the instructor to review the results. The instructor will share their grading evaluation of the lessons covered. Learner and instructor shall come to an agreed upon percentage score after review. Determination of any needed remedial instruction and study shall be guided by the instructor.

□ Local Dual Flight #2

FLIGHT TIME: 1.5 hours

▪**Instructor Actions**- Co-develop a flight plan based on a pre-selected real world scenario. The instructor will provide the outline for an IFR flight to an airport served by radar controllers and published approaches. The student will create the flight plan in the system FMS and have it reviewed by the instructor. Risk checklists will be applied and discussed prior to flying. Flying conditions should be VFR with IFR plan on file to include simulated alternate airports. Fly the plan after preflight, with a single pilot resource discussion included. The instructor may aid the student in system operation when needed, with the intent of shifting to single pilot actions. Autopilot functions are expected to be used in all phases of flight as well as written checklists. Vision limiting devices are only warranted for a short period of this flight. Cognizance of pilot overload is paramount for the instructor. Repeat the post flight debrief as above.

Give the pilot the material to study for Day 2 training and if time permits, spend a few minutes quizzing the pilot on information that should have been retained from the day of training.

Learner Actions- To facilitate learner centered grading, the student will complete an evaluation of the dual flight. A percentage score will be self assigned using 70% as the passing level. Achievement of 85% is the desired goal before proceeding to each next step of training. After self evaluation, the learner shall consult with the instructor to review the results. The instructor will share their grading evaluation of the lessons covered. Learner and instructor shall come to an agreed upon percentage score after review. Determination of any needed remedial instruction and study shall be guided by the instructor.

Estimated time to Complete:7 to 8hours

OBJECTIVE- Day 2 training should finish with the pilot having the ability to appropriately load and fly VOR, GPS, ILS and NDB approaches (where available). After this day in training, the pilot should also have a thorough understanding of the role of the autopilot on these approaches.
NOTE- As training progresses, the use of a view limiting device, such as a pair of foggles, may be incorporated at times to simulate the IFR environment.

GROUND SCHOOL OUTLINE:

Allotted Time: 3 hours 15 minutes

NOTE- For the following items, training is best accomplished using either a desktop or aircraft installed IDU in Demonstrator/Training Mode. Additional materials: from the **Instructor toolkit** - screen capture photographs.

- **Loading a Basic Non-Precision Approach (Full Procedure)** (pg 7-1 through 7-24) *TIME: 45min*
  - VOR
  - NDB
  - GPS Standalone/Overlay
  - **Instructor Actions-** In this section, the goal is to comfortably load approaches. Discuss using functions such as NRST to add a destination airport in the active list. At this time it is also important to explain the importance of having the ground based facility tuned and monitored during approaches that are not approved as an overlay. Approved sole source approaches are noted with an asterisk next to the approach name. During a standard VOR approach, the pilot must have the VOR required for the approach tuned into a NAV receiver and also have some means for monitoring that signal. The preferred method of monitoring the ground based signal is on the PFD displayed HSI. This allows a more precise approach through the HITS. Once an approach has been activated, have the pilot review the ACTV list to ensure the data contained within the EFIS (JEPP data) conforms to the paper chart data. Spend the time to load more than one approach at different airports both familiar and unfamiliar to the pilot. Use features such as MIN ALT and DECISION HT located under the BUGS function to set information such as the MDA for the selected approach. Another very useful tool is the ZOOM ON function to aide in situational awareness while breaking out of the clouds and transitioning to visual references. Discuss autopilot modes and source annunciation on PFD.

Loading a Basic Precision Approach (Full Procedure) (pg 7-26 through 7-28) *TIME: 30min*

- **Instructor Actions**- Load a series of ILS approaches into the EFIS. While the EFIS is capable of depicting the entire ILS approach, including the approach slope through the HITS, the ILS itself is required to be used as the primary reference during the approach. Again, the preferred method to utilize the ILS is through the HSI displayed on the PFD.

- **Vectors to Final** (pg 7-24 through 7-26)

TIME: 30min

▪**Instructor Actions**- Vectors to final is the most widely used method to get us on the approach. It is necessary to ensure that the pilot is capable of using this function, and more importantly, the autopilot. When loading an approach with vectors to final (VTF), it is important that the heading bug be used. The EFIS will designate an imaginary fix in space (IP) fifteen NM from the FAF

and draw a magenta line between the two. At this point, the HITS will move onto this line. When the heading bug is turned off or LNAV is armed, the autopilot will hold present heading until intercepting the final approach course.

- **The Missed** (pg 7-29 through 7-32)

TIME: 30min

▪**Instructor Actions**- Get the pilot in the habit of pressing the ARM key after crossing the FAF. Pressing the ARM soft key and activating the ZOOM ON function inside the FAF are good habits to teach to the pilot. If the missed approach involves holding, the EFIS will automatically determine the hold entry and depict the entry as part of the missed. After its completion, it will declutter the entry from the procedure shown on the MFD. Once established in the hold, a CONTINUE soft key will appear in the same location as MISSED if a further waypoint is included in the flightplan. The CONTINUE button may be pressed at anytime during the hold, and the EFIS will complete the current lap in the hold prior to continuing on to the next waypoint.

2 DAY 2 CONTINUED

□ **Aircraft Preflight and Preflight Discussion**

TIME: 45min

▪**Instructor Actions**- Make at least two copies of all approach procedures that are to be used during the flight. Having two copies of the approaches will allow both the pilot and instructor easy access to the approaches. As on day one, a simulated IFR scenario will be utilized for training. This will be accomplished in an ATC environment under VFR conditions while on an active IFR flight plan.

FLIGHT TRAINING OUTLINE:

Allotted Time:5 hours

NOTE- Due to the extensive amount of flying allotted for Day 2 training, the flight portion has been broken down into two separate flights to allow for an instructional ground period between the two flights.

□ Local Dual Flight #3

FLIGHT TIME: 2 hours

▪**Instructor Actions**- The first few approaches should be local and done *without* a view limiting device. Again, while the EFIS is capable of displaying all published approaches with HITS, the ground based navigation facility must be monitored and be considered the primary reference for the approach unless the approach is GPS sole source and noted with an asterisk. One factor that will aide greatly in a positive learning environment is to slow the aircraft's speed. Use of the autopilot during approaches will aid in developing **single pilot resource techniques.** These first flights with instrument approaches should include all forms of precision and non-precision approaches applicable to the airport where training. Ideally, within a two hour flight period, approximately five to six approaches can be executed including missed approaches and holding.

□ Local Dual Flight #3 Debrief

TIME: 30 min

▪**Instructor Actions**-, make sure all questions are addressed thoroughly. As the instructor, you should have taken some notes from the flight and discussed these with the pilot in conjunction with their questions. Pay particular attention to resource management observations and actions taken to enhance safe outcomes. Review any procedures involving autopilot integration that are not clear to the student.

Learner Actions- To facilitate learner centered grading, the student will complete an evaluation of the dual flight. A percentage score will be self assigned using 70% as the passing level. Achievement of 85% is the desired goal before proceeding to each next step of training. After self evaluation, the learner shall consult with the

instructor to review the results. The instructor will share their grading evaluation of the lessons covered. Learner and instructor shall come to an agreed upon percentage score after review. Determination of any needed remedial instruction and study shall be guided by the instructor.

□ Dual Flight #4

FLIGHT TIME: 2 hours

▪**Instructor Actions**- Assign a written scenario for an IFR flight to an airport somewhat unfamiliar to the pilot. Allow time for the student to plan the trip with minimal input from the instructor. If mutually agreeable, this flight may take place in light IFR conditions or a view limiting device may be employed above 1000 ft. agl. Ideally, a busy airport with complete ATC services will be chosen. **Checklists for aircraft operation, risk management and IFR planning should be required.** Weather, fuel planning and decision making should be critically reviewed by the instructor. Any doubts about a successful outcome of the flight will be grounds for postponement. The flight should proceed with little input from the instructor outside the realm of normal distractions and discussion of ongoing decision making. At an appropriate time in the flight, abnormal procedures may be introduced including sensor failure and utilization of back up instrumentation. These should be brief with an understanding of real world mean time between failure data.

□ Dual Flight #4 Postflight Discussion & DAY 2 Debrief

TIME: 45 min

▪**Instructor Actions**- By this point in training, the pilot should have an understanding and operational knowledge of the EFIS system under *normal* and limited abnormal flight regimes. This includes, but is not limited to:

□ GPS Approaches	□ Missed Approach Functions
□ VOR Approaches	□ Holding Procedures
□ ILS/LOC Approaches	□ Autopilot Operation
□ NDB Approaches	□ As Assigned by Instructor

Review with the pilot all training covered to date and ensure that there are no unanswered questions. Discuss all flights start to finish and critique the pilot to allow them to build on their mistakes.

Learner Actions- To facilitate learner centered grading, the student will complete an evaluation of the dual flight. A percentage score will be self assigned using 70% as the passing level. Achievement of 85% is the desired goal before proceeding to each next step of training. After self evaluation, the learner shall consult with the instructor to review the results. The instructor will share their grading evaluation of the lessons covered. Learner and instructor shall come to an agreed upon percentage score after review. Determination of any needed remedial instruction and study shall be guided by the instructor.

3 DAY 3

Estimated time to Complete: 8hours 45 minutes

OBJECTIVE- Training on Day 3 should consist of familiarizing the pilot with enroute, abnormal and emergency situations.

GROUND SCHOOL OUTLINE:

Allotted Time: 3 hours 30 minutes

- ☐ **Enroute Navigation** (pg 7-33 through 7-4)

  TIME: 60 min

  ▪**Instructor Actions**- Using an EFIS in Demonstrator/Training Mode, build some flight plans to and from larger airports that have Departure Procedures (DP's) and Standard Terminal Arrival Routes (STAR's). Issue the pilot a simulated ATC clearance and allow them to load these procedures and their flight plan into the EFIS. Flight planning features such as victor airways should be introduced at this time. After building a specific flight plan, load the flight plan and then require the pilot to modify the route "on the fly." Vectors and shortcuts are the everyday practice of ATC, so ensure that the pilot is familiar with modifying active routes within the ACTV function. Additionally, point out that certain fixes on RNAV approaches are computer navigation fixes referenced only by GPS receivers. Discuss discontinuities, causes and method of navigation across gaps in computed course.

- ☐ **Failure Modes** (pg 3-130 through 3-142 & Appendix 8-1 through 8-4)

  TIME: 90 min

  ▪**Instructor Actions**- Cover the list of failure modes listed in the manual and explain to the pilot the actions necessary to mitigate the situation. They should be familiar with information expected to be missing in the event of an equipment failure (ex. Air Data Computer). This segment should be predicated on "what if" questions and actual scenarios that are possible while flying. Below is a list of failures that may occur, and the pilot should be familiar with on screen indications, audible warnings and precautions to be taken.

  - ☐ GPS Failure
  - ☐ AHRS Failure
  - ☐ ADC Failure
  - ☐ Auxiliary Sensor Failure

- ☐ **Unusual Attitude Recovery** (pg 3-6)

  TIME: 30 min

  ▪**Instructor Actions**- While this feature is not possible to demonstrate in simulation, talk with the pilot about basic recovery procedures and refer to the PFD image on page 3-6 of the pilot operating guide. This flight regime will be practiced later in flight training. Explain the actions that the EFIS will take automatically in the event the UAR mode is activated (ex. Removal of all terrain, obstructions and CDI / Annunciator.

□ **Aircraft Preflight and Preflight Discussion**

TIME: 30min

▪**Instructor Actions**- Due to the length of Day 3 flight training, it should be divided into two separate flights. Plan the time accordingly to accomplish all newly introduced items and to allow for a review.

FLIGHT TRAINING OUTLINE:

Allotted Time: 5 hours

□ Local Dual Flight #5

FLIGHT TIME: 1-2 hours

▪**Instructor Actions**- Begin the flight with issuing a simulated ATC clearance to follow a departure procedure if the training airport has a published procedure. Depart the airport environment to complete some upper air work. This training should include unusual attitudes both with and with out the EFIS. Fail individual sensors and components as described in the ground training outline for Day 3. Failures can be accomplished simply by pulling a circuit breaker (doing so is harmless to the components). Allow the pilot to identify the failed system and explain the appropriate actions to be taken. Return to the airport and execute a series of approaches with failed instrumentation. For example, fail the AHRS and allow the pilot to develop a scan with the backup instruments. For the most part, this flight should be heavily oriented towards "realistic" failures that can occur within the normal flight environment. Other failures should include failure of the PFD and MFD while on approaches, enroute and while emergency situations such as unusual attitude recoveries.

□ Local Dual Flight #5 Debrief

TIME: 30 min

▪**Instructor Actions**- Review all covered material and discuss the decisions made in relation to risk identification and risk mitigation. Introduce alternative scenarios, for discussion purposes, to allow the student to identify further potential risks. Referencing commercial products such as King Schools risk management course will aid the student in gaining these skills.

Learner Actions- To facilitate learner centered grading, the student will complete an evaluation of the dual flight. A percentage score will be self assigned using 70% as the passing level. Achievement of 85% is the desired goal before proceeding to each next step of training. After self evaluation, the learner shall consult with the instructor to review the results. The instructor will share their grading evaluation of the lessons covered. Learner and instructor shall come to an agreed upon percentage score after review. Determination of any needed remedial instruction and study shall be guided by the instructor.

□ Local Dual Flight #6

FLIGHT TIME: 1.5 hours

▪**Instructor Actions**- Treat this flight as a simulated check ride. If proceeding normally, this flight should evolve into a graduation exercise. If, at the discretion of the instructor, additional time is needed for comfortable operation in real world busy ATC environments, this flight may be followed with a later IFR cross country flight. Items to be covered on this flight are as follows, but not limited to:

□ GPS Approaches
□ VOR Approaches
□ ILS/LOC Approaches
□ NDB Approaches
□ Terrain/Traffic Awareness
□ Failure Modes
□ **Single pilot resource management**
□ Holding Procedures
□ Autopilot Operation
□ Enroute Navigation/ Flight Planning
□ Risk identification
□ **Risk mitigation**

□ Local Dual Flight #6 Postflight Discussion & DAY 3 Debrief

TIME: 45 min

▪**Instructor Actions**- Give the pilot a complete critique of their knowledge and flying abilities as they apply to the skills of a pilot transitioning to a TAA. It is important to remember that these pilots already are rated to fly the aircraft, but the element of unfamiliarity with glass cockpits may cause the pilot's aviating abilities to appear degraded At the combined discretion of the pilot and instructor, additional training may be conducted.

▪**Instructor materials - PAVE checklist** from **Instructor toolkit**

Learner Actions- To facilitate learner centered grading, the student will complete an evaluation of the dual flight. A percentage score will be self assigned using 70% as the passing level. Achievement of 85% is the desired goal before proceeding to each next step of training. After self evaluation, the learner shall consult with the instructor to review the results. The instructor will share their grading evaluation of the lessons covered. Learner and instructor shall come to an agreed upon percentage score after review. Determination of any needed remedial instruction and study shall be guided by the instructor.

TRAINING COMPLETION CHECKLIST

_____hrs/min of Ground Training (11hours 45minutes Recommended)

_____hrs/min of Flight Training (10 +hours Recommended)

_____hrs/min of Postflight Discussion (2hours 30minutes Recommended)

•Suggested Logbook Endorsement:

I certify that _____ _____(First, MI, Last/ Certificate #) has satisfactorily completed the Chelton Flight Systems Initial EFIS ground and flight training course of instruction on _____(date).

_____ (CFI Signature/ Number & Exp. Date

For 14 CFR Part 135 Air Carrier operations, training shall be conducted under 14 CFR Part 135 in accordance with their approved training programs.

7. FSB Specifications for Checking

Flight checks are conducted in accordance with the instruction, guidance, and requirements contained in the Practical Test Standards and supplemented by guidance in FAA Orders 8900.1 and/or 8710.3.

8. FSB Specifications for Currency

Currency shall be maintained in accordance with 14 CFR Part 61.57 and 61.58 and CFR Part 135.297..

9. Aircraft regulatory compliance checklist

N/A

10. FSB Specifications for Devices and Simulators

Advisory Circular 120-63 outlines specifications for Helicopter simulators.

11. Application of FSB Report

All Operators

12. Alternate means of compliance

N/A

13. Miscellaneous - N/A

BHT-412 CHELTON FLIGHT LOGIC EFIS DISPLAY

PART II

1.0 Background: During the period April 6, 2009 through April 10, 2009, a Flight Standardization Board was convened in Broussard, Louisiana to evaluate the Chelton FlightLogic EFIS installation in the BHT-412SP.

2.0 FSB Composition:

Chairman – Edward L. Hinch, Operations Inspector, Fort Worth Aircraft Evaluation Group.

Board Member - Steven Sorich, Operations Inspector, Fort Worth Aircraft Evaluation Group.

3.0 There are no outstanding Aircraft Evaluation Group issue papers.

4.0 Type Ratings and Crew Qualification Tests, and FSB Determinations:

Due to the complexity and unique nature of the pilot displays and controls, advanced avionics and new technology incorporated into navigation and flight control systems, pilots transitioning to this system must be instrument proficient prior to beginning the required training.

5.0 Summary and Conclusions: Each Board member concurs in determining the requirement for type specific training in accordance with 14 CFR Part 61.31(h) to be established for this aircraft. Flight checks are to be conducted in accordance with the instruction, guidance, and requirements contained in Practical Test Standards and supplemented by guidance in FAA Order 8900.1 and/or 8710.3.