Appendix C:

Autopilot & GPS Information

NTSB Aircraft Accident Case No. NYC99MA178
Vineyard Haven, Massachusetts
July 16, 1999
Piper PA-32R-301; N9253N

King Radio Corp.
400 N. Rogers Road
Olathe, Kansas 66062
PFS015-3

FAA APPROVED

AIRPLANE FLIGHT MANUAL SUPPLEMENT

FOR

PIPER MODELS PA-32R-301 & 301T

WITH

KING 150 SERIES FLIGHT CONTROL SYSTEM

Reg. No. _____

Ser. No. _____

The information contained in this manual is FAA Approved material which, along with the FAA Approved Airplane Flight Manual, placards and instrument markings, is applicable to the operation of the airplane when modified by the installation of the King 150 Series Automatic Flight Control System as per STC SA1572CE-D.

FAA Approved: [redacted]

RALPH V. COLE
DAS Coordinator
King Radio Corporation
DAS4CE

Date: November 1, 1982

006-0414-01

PIPER MODELS PA-32R-301 & 301T

FAA APPROVED

AIRPLANE FLIGHT MANUAL SUPPLEMENT

TABLE OF CONTENTS

SECTION 1 - GENERAL

This manual is provided to acquaint the pilot with the limitations as well as normal and emergency operating procedures of the King 150 Series Automatic Flight Control Systems. The limitations presented are pertinent to the operation of the 150 System as installed in the Piper Models PA-32R-301 & 301T airplanes; the Flight Control Systems must be operated within the limitations herein specified.

The 150 Series AFCS is certified in this airplane with 2 axis control, pitch and roll. The various instruments and the controls for the operation of the 150 System are described in Figure 1.

The 150 Series AFCS has an electric pitch trim system which provides autotrim during autopilot operation and manual electric trim for the pilot. The trim system is designed to withstand any single inflight malfunction. Trim faults are visually and aurally annunciated.

A lockout device prevents autopilot engagement until the system has been successfully preflight tested.

The following conditions will cause the Autopilot to automatically disengage:

A. Power failure.

B. Internal Flight Control System failure.

C. With the KCS 55A Compass System, a loss of compass valid (displaying HDG flag) disengages the Autopilot when a mode using heading information is engaged. With the HDG flag present, the Autopilot may be re-engaged in the basic wings level mode along with any vertical mode.

D. Roll rates in excess of 14° per second will cause the autopilot to disengage except when the CWS switch is held depressed.

E. Pitch rates in excess of 8° per second will cause the autopilot to disengage except when the CWS switch is held depressed.

SECTION 1
GENERAL

1. KFC 150 SYSTEM KC 192 AUTOPILOT COMPUTER - Complete Flight Director and Autopilot computer, including system mode annunciators and system controls.

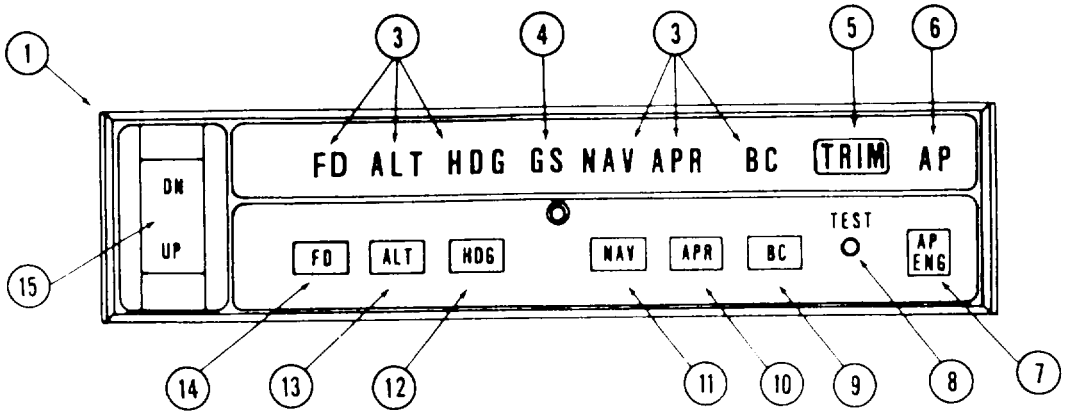
2. NOT USED

3. MODE ANNUNCIATORS - Illuminate when a mode is selected by the corresponding mode selector button (PUSH ON - PUSH OFF).

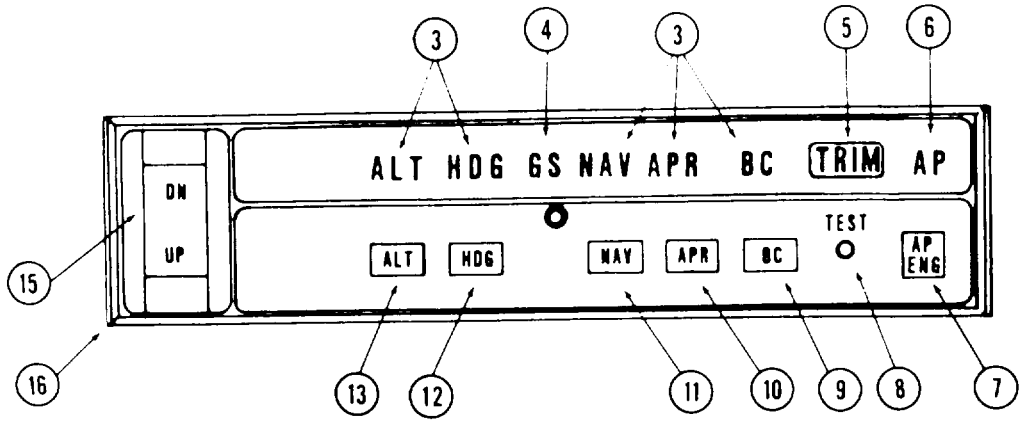
4. GLIDESLOPE (GS) ANNUNCIATOR - Illuminates continuously whenever the autopilot is coupled to the glideslope signal. The GS annunciator will flash if the glideslope signal is lost (GS flag in CDI or absence of glideslope pointers in KI 525A). The autopilot reverts to pitch attitude hold operation. If a valid glideslope signal returns within six seconds, the autopilot will automatically recouple in the GS mode. If the valid signal does not return within six seconds, the autopilot will remain in pitch attitude hold mode until such time that a valid glideslope returns and the aircraft passes thru the glideslope. At that point GS couple will re-occur.

5. TRIM WARNING LIGHT (TRIM) - Illuminates continuously whenever trim power is not on or the system has not been preflight tested. THE TRIM warning light illuminates and is accompanied by an audible warning whenever a manual trim fault is detected. The Manual Trim System is monitored for the Trim Servo running without a command. The TRIM warning light will illuminate and be accompanied by an audible tone whenever an autotrim failure occurs. The autotrim system is monitored for the following failures: trim servo running without a command; trim servo not running when commanded to run; trim servo running in the wrong direction. The Trim Circuit Breaker may be cycled off to silence the continuous tone but the trim fail light will remain on. Manual Electric Trim may be used but the autopilot should not be engaged.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS



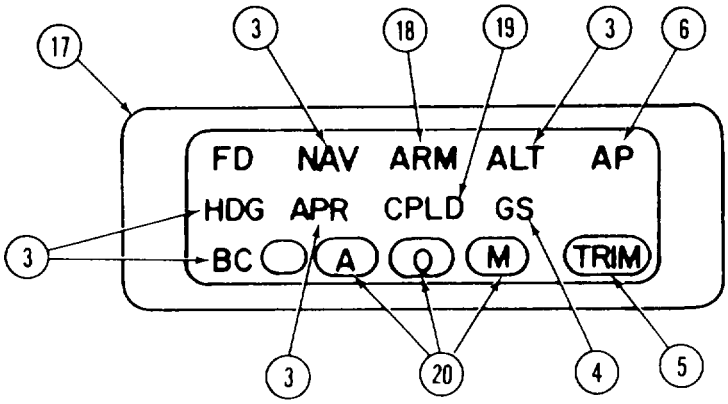
KC 192 AUTOPILOT & FLIGHT DIRECTOR COMPUTER



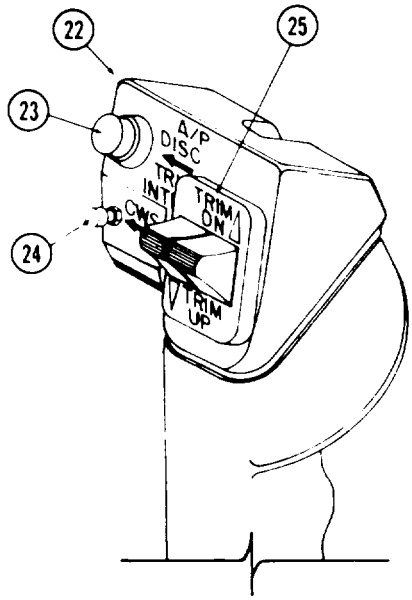
KC 191 AUTOPILOT COMPUTER

FIGURE 1 KING 150 AUTOPILOT SYSTEM
COMPUTERS AND ATTITUDE GYROS

SECTION 1
GENERAL



KA 185 REMOTE MODE ANNUNCIATOR
(OPTIONAL)



AUTOPILOT CONTROL WHEEL SWITCH CAP

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

6. AUTOPILOT (AP) ANNUNCIATOR - Illuminates continuously whenever the autopilot is engaged. Flashes approximately 12 times whenever the autopilot is disengaged (an aural alert will also sound for 2 seconds).

7. AUTOPILOT ENGAGE (AP ENG) BUTTON - When pushed, engages autopilot if all logic conditions are met.

8. PREFLIGHT TEST (TEST) BUTTON - When momentarily pushed, initiates preflight test sequence which automatically turns on all annunciator lights, tests the roll and pitch rate monitors, tests the autotrim fault monitor, checks the manual trim drive voltage and tests all autopilot valid and dump logic. If the preflight is successfully passed, the AP annunciator light will flash for approximately 6 seconds (an aural tone will also sound simultaneously with the annunciator flashes). The autopilot can not be engaged until the autopilot preflight tests are successfully passed.

9. BACK COURSE APPROACH (BC) MODE SELECTOR BUTTON - When pushed will select the Back Course Approach mode. This mode functions identically to the approach mode except that response to LOC signals is reversed. Glideslope coupling is inhibited in the Back Course Approach mode.

10. APPROACH (APR) MODE SELECTOR BUTTON - When pushed, will select the Approach mode. This mode provides all angle intercept (with HSI) or a fixed angle intercept of 45° (with DG), automatic beam capture and tracking of VOR, RNAV or LOC signals plus Glideslope coupling in the case of an ILS. The tracking gain of the APR mode is greater than the gain in the NAV mode. The APR annunciator on the Autopilot Computer will flash until the automatic capture sequence is initiated. On the KA 185 Remote Mode Annunciator, APR ARM will annunciate until the automatic capture sequence is initiated. At beam capture, APR CPLD will annunciate.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

11. NAVIGATION (NAV) MODE SELECTOR BUTTON - When pushed will select the Navigation mode. The mode provides all angle intercept (with HSI) or a fixed angle intercept of 45° (with DG), automatic beam capture and tracking of VOR, RNAV or LOC signals. The NAV annunciator on the Autopilot Computer will flash until the automatic capture sequence is initiated. On the KA 185 Remote Mode Annunciator, NAV ARM will annunciate until the automatic capture sequence is initiated. At beam capture, NAV CPLD will annunciate.

12. HEADING (HDG) MODE SELECTOR BUTTON - When pushed will select the Heading mode, which commands the airplane to turn to and maintain the heading selected by the heading bug on the DG or HSI. A new heading may be selected at any time and will result in the airplane turning to the new heading with a maximum bank angle of about 22°. Selecting HDG mode will cancel NAV, APR or BC track modes.

13. ALTITUDE HOLD (ALT) MODE SELECTOR BUTTON - When pushed will select the Altitude Hold mode, which commands the airplane to maintain the pressure altitude existing at the moment of selection. Engagement may be accomplished in climb, descent, or level flight. In the APR mode, altitude hold will automatically disengage when the glideslope is captured.

14. FLIGHT DIRECTOR (FD) MODE SELECTOR BUTTON - When Pushed will select the Flight Director mode (with KC 192 Autopilot Computer only), bringing the Command Bar in view on the KI 256 and will command wings level and pitch attitude hold. The FD mode must be selected prior to Autopilot engagement.

15. VERTICAL TRIM CONTROL - A spring loaded to center rocker switch which will provide up or down pitch command changes: while in ALT will adjust altitude at rate of about 500 fpm; when not in ALT will adjust pitch attitude at a rate of .7 deg/sec.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

Will cancel GS couple. The aircraft must pass through the glideslope again to allow GS recouple.

16. KAP 150 SYSTEM KC 191 AUTOPILOT COMPUTER - Complete Autopilot computer, including system mode annunciators and system controls.

17. KA 185 REMOTE MODE ANNUNCIATOR (OPTIONAL) - Provides mode annunciation in the pilots' primary scan area as well as three Marker Beacon lights.

18. ARMED (ARM) ANNUNCIATOR - Illuminates continuously along with NAV or APR when either the NAV or APR mode selector button is depressed. The ARM annunciator will continue to illuminate until the automatic capture sequence is initiated at which time ARM will extinguish and CPLD will annunciate.

19. COUPLED (CPLD) ANNUNCIATOR - Illuminates continuously along with NAV or APR at the initiation of automatic beam capture sequence in either the NAV or APR modes. Normally the CPLD condition follows an ARM condition but may be entered into directly if the beam capture criteria is met when NAV or APR is selected.

20. REMOTE MARKER BEACON LIGHTS - Remote Airway, Outer and Middle Marker Beacon lights driven by the Marker Beacon receiver.

21. NOT USED.

22. AUTOPILOT CONTROL WHEEL SWITCH ASSEMBLY - Switch assembly mounted on the pilot's control wheel associated with the autopilot and manual electric trim systems.

23. AUTOPILOT DISCONNECT/TRIM INTERRUPT (A/P DISC/TRIM INTER) Switch - When depressed will disengage the autopilot and cancel all operating Flight Director modes. When depressed and held will interrupt all

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

electric trim power (stop trim motion), disengage the autopilot and cancel all operating Flight Director modes.

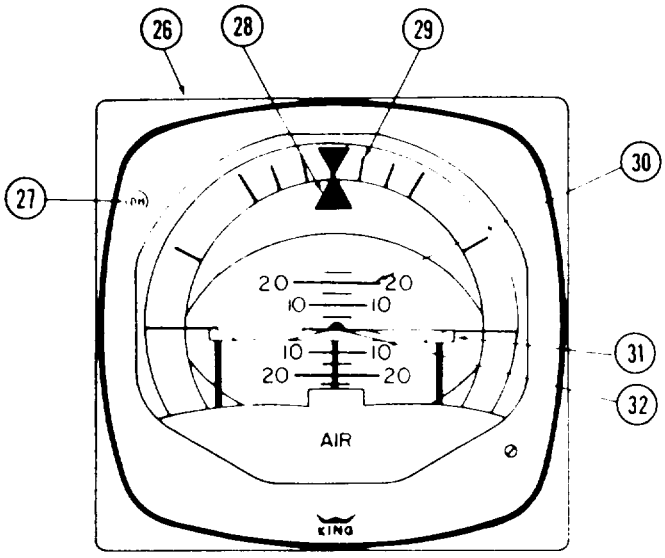
24. CONTROL WHEEL STEERING (CWS) BUTTON - When depressed, allows pilot to manually control the aircraft (disengages the pitch and roll servos) without cancellation of any of the selected modes. Will engage the Flight Director mode if not previously engaged. Automatically synchronizes the Flight Director/Autopilot to the pitch attitude present when the CWS switch is released, or to the present pressure altitude when operating in the ALT hold mode. Will cancel GS couple. The aircraft must pass through the glideslope again to allow GS recouple. The CWS button will not disengage the Yaw Damper Servo.

25. MANUAL ELECTRIC TRIM CONTROL SWITCHES - A split switch unit in which the left half provides power to engage the trim servo clutch and the right half to control the direction of motion of the trim servo motor. Both halves of the split trim switch must be actuated in order for the manual trim to coperate in the desired direction. When the autopilot is engaged, operation of the manual electric trim will automatically disconnect the autopilot.

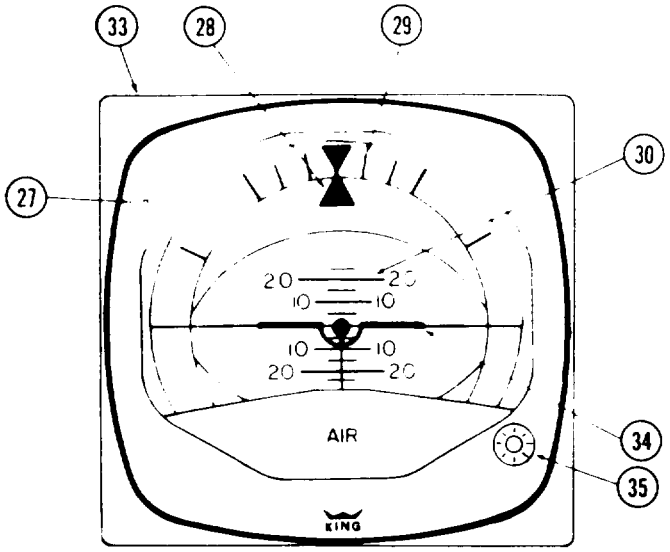
26. KI 256 FLIGHT COMMAND INDICATOR (FCI) - Displays airplane attitude as a conventional attitude gyro and displays commands for flight director operation. The gyro is air driven.

27. DECISION HEIGHT (DH) ANNUNCIATOR LIGHT - Optional light for use with the aircraft's optional radar altimeter.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS



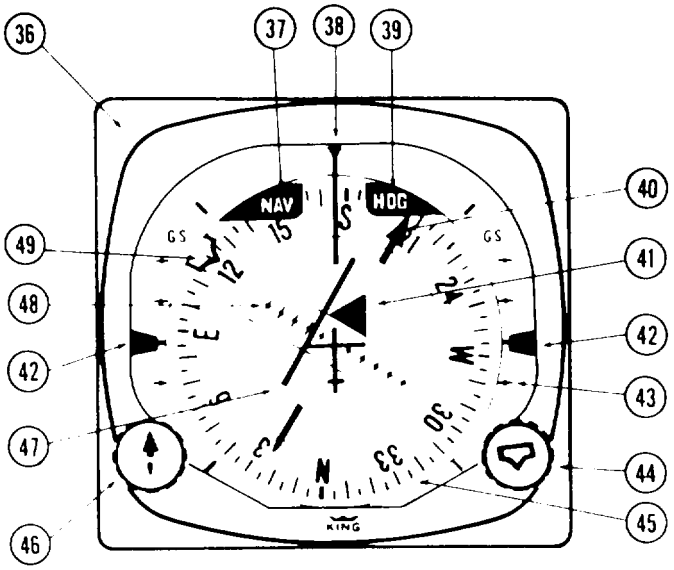
KI 256 FLIGHT COMMAND INDICATOR



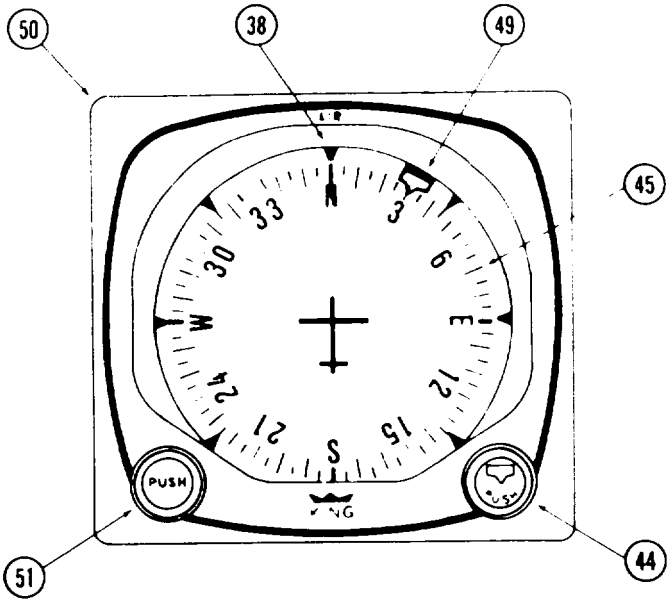
KG 258 VERTICAL GYRO

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

SECTION 1
GENERAL



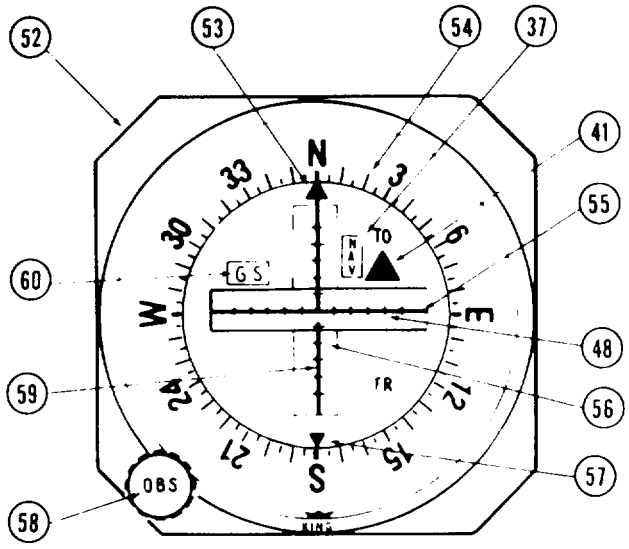
KI 525A HSI



KG 107 DG

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

Piper Models PA-32R-310 & 301T
Airplane Flight Manual Supplement



KI 204/206 VOR/LOC/GS INDICATOR

28. ROLL ATTITUDE INDEX - Displays airplane roll attitude with respect to the roll attitude scale.

29. ROLL ATTITUDE SCALE - Scale marked at 0, ±10,20,30,60 and 90 degrees.

30. PITCH ATTITUDE SCALE - Moves with respect to the symbolic airplane to present pitch attitude. Scale graduated at 0, ±5,10,15,20 and 25 degrees.

31. COMMAND BAR - Displays computed steering commands referenced to the symbolic airplane. The command bar is visible only when FD mode is selected. The command bar will be biased out of view whenever the system is invalid or a Flight Director mode is not engaged.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

SECTION 1
GENERAL

32. FCI SYMBOLIC AIRPLANE - Airplane pitch and roll attitude is displayed by the relationship between the fixed symbolic airplane and the movable background.

    During flight director operation, the symbolic airplane is flown to align it with the command bar to satisfy the flight director commands.

33. KG 258 VERTICAL GYRO - Displays airplane attitude as a conventional attitude gyro. The gyro is air driven.

34. SYMBOLIC AIRPLANE - Serves as a stationary symbol of the aircraft. Aircraft pitch and roll attitudes are displayed by the relationship between the fixed symbolic aircraft and the movable background.

35. SYMBOLIC AIRCRAFT ALIGNMENT KNOB - Provides manual positioning of the symbolic aircraft for level flight under various load conditions.

36. KI 525A HORIZONTAL SITUATION INDICATOR (HSI) - Provides a pictorial presentation of aircraft deviation relative to VOR radials or localizer beams. It also displays glideslope deviations and gives heading reference with respect to magnetic north.

37. NAV FLAG - Flag is in view when the NAV receiver signal is inadequate. When a NAV flag is present in the navigation indicator (CDI or KI 525A) the autopilot operation is not affected. The pilot must monitor the navigation indicators for NAV flags to insure that the Autopilot and/or Flight Director are tracking valid navigation information.

38. LUBBER LINE - Indicates aircraft magnetic heading on compass card (45).

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

39. HEADING WARNING FLAG (HDG) - When flag is in view the heading display is invalid. If a HDG flag appears and a lateral mode (HDG, NAV, APR or APR BC) is selected, the Autopilot will be disengaged. The Autpoilot may be re-engaged in the basic wings level mode along with any vertical mode. The CWS switch would be used to manually maneuver the aircraft laterally.

40. COURSE BEARING POINTER - Indicates selected VOR course or localizer course on compass card (45). The selected VOR radial or localizer heading remains set on the compass card when the compass card (45) rotates.

41. TO/FROM INDICATOR FLAG - Indicates direction of VOR station relative to selected course.

42. DUAL GLIDESLOPE POINTERS - Indicate on glideslope scale (43) aircraft displacement from glideslope beam center. Glideslope pointers in view indicate a usable glideslope signal is being received.

43. GLIDESLOPE SCALES - Indicate displacement from glideslope beam center. A glideslope deviation bar displacement of 2 dots, represents full scale (0.7^{o}) deviation above or below glideslope beam centerline.

44. HEADING SELECTOR KNOB () - Positions heading bug (49) on compass card (45) by rotating the heading selector knob. The Bug rotates with the compass card.

45. COMPASS CARD - Rotates to display heading of airplane with reference to lubber line (38) on HSI or DG.

46. COURSE SELECTOR KNOB - Positions course bearing pointer (40) on the compass card (45) by rotating the course selector knob.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

SECTION 1
GENERAL

47. COURSE DEVIATION BAR (D-BAR) - The center portion of omni bearing pointer moves laterally to pictorially indicate the relationship of aircraft to the selected course. It indicates degrees of angular displacement from VOR radials and localizer beams, or displacement in nautical miles from RNAV courses.

48. COURSE DEVIATION SCALE - A course deviation bar displacement of 5 dots represents full scale (VOR = $\pm 10^{\circ}$, LOC = $\pm 2\ 1/2^{\circ}$, RNAV = 5NM, RNAV APR = 1 1/4NM) deviation from beam centerline.

49. HEADING BUG - Moved by knob (44) to select desired heading.

50. KG 107 NON-SLAVED DIRECTIONAL GYRO (DG) - Provides a stable visual indication of aircraft heading to the pilot. The gyro is air driven.

51. GYRO ADJUSTMENT KNOB (PUSH) - When pushed in, allows the pilot to manually rotate the gyro compass card (45) to correspond with the magnetic heading indicated by the magnetic compass. The unslaved compass card must be manually reset periodically to compensate for precessional errors in the gyro.

52. KI 204/206 VOR/LOC/GLIDESLOPE INDICATOR - Provides rectilinear display of VOR/LOC and Glidelope deviation.

53. COURSE INDEX - Indicates selected VOR course.

54. COURSE CARD - Indicates selected VOR course under course index.

55. GLIDESLOPE DEVIATION NEEDLE - Indicates deviation from ILS glideslope.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

56. GLIDESLOPE SCALE - Indicates displacement from glideslope beam center. A glideslope deviation needle displacement of 5 dots, represents full scale (0.7°) deviation above or below glideslope beam centerline.

57. RECIPROCAL COURSE INDEX - Indicates reciprocal of selected VOR course.

58. OMNI BEARING SELECTOR (OBS) KNOB - Rotates course card to selected course.

59. COURSE DEVIATION NEEDLE - Indicates course deviation from selected omni course or localizer centerline.

60. GLIDESLOPE (GS) FLAG - Flag is in view when the GS receiver signal is inadequate.

FIGURE 1 KING 150 AUTOPILOT SYSTEM
CONTROLS AND INDICATORS

The airplane MASTER SWITCH function is unchanged and can be used in an emergency to shut off electrical power to all flight control systems while the problem is isolated.

The RADIO POWER/AVIONICS MASTER switch supplies power to the avionics bus bar of the radio circuit breakers and the autopilot circuit breaker.

The following circuit breakers are used to protect the following elements of the King 150 Series Autopilot:

LABEL	FUNCTION
AUTOPILOT	Supplies power to the KC 192 or the KC 191 Computer, the autopilot pitch and roll servos, and the Pitch Trim Circuit Breaker.
PITCH TRIM	Supplies power to the autotrim and manual electric pitch trim systems.
COMP-SYSTEM	Supplies power to the optional KCS 55A Compass System.

SECTION 2 - LIMITATIONS

A. During autopilot operation, a pilot with seat belt fastened must be seated at the left pilot position.

B. The autopilot must be OFF during takeoff and landing.

C. The system is approved for Category I operation only (Approach mode selected).

D. Autopilot airspeed limitation: Maximum 175 KIAS.

E. Autopilot flap limitation: Maximum flap extension 25° (2nd notch).

F. Maximum fuel imbalance - 12 gallons.

NOTE

IN ACCORDANCE WITH FAA RECOMMENDATION, USE OF "ALTITUDE HOLD" MODE IS NOT RECOMMENDED DURING OPERATION IN SEVERE TURBULENCE.

PLACARDS:

NONE

SECTION 3 - EMERGENCY PROCEDURES

A. In case of Autopilot malfunction: (accomplish Items 1 and 2 simultaneously)

1. Airplane Control Wheel - GRASP FIRMLY and regain aircraft control.

2. A/P DISC/TRIM INTER Switch - PRESS and HOLD.

B. In case of Electric Trim Malfunction (either manual electric or autotrim):

1. A/P DISC/TRIM INTER Switch - PRESS and HOLD throughout recovery.

2. PITCH TRIM Circuit Breaker - PULL.

3. Aircraft - RETRIM manually.

CAUTION

WHEN DISCONNECTING THE AUTOPILOT AFTER A TRIM MALFUNCTION, HOLD THE CONTROL WHEEL FIRMLY; UP TO 45 POUNDS OF FORCE ON THE CONTROL WHEEL MAY BE NECESSARY TO HOLD THE AIRCRAFT LEVEL.

Maximum Altitude losses due to autopilot malfunction:

Configuration	ALT Loss
Cruise, Climb, Descent	300'
Maneuvering	75'
APPR	60'

SECTION 4 - NORMAL PROCEDURES

A. Preflight (Perform prior to each flight)

1. GYROS - Allow 3-4 minutes for gyros to come up to speed.

2. RADIO POWER/AVIONICS MASTER Switch - ON

3. PREFLIGHT TEST BUTTON - PRESS momentarily and NOTE:

   a. All annunciator lights on (TRIM annunciator flashing).

   b. After approximately 5 seconds, all annunciator lights off except AP which will flash approximately 12 times and then remain off.

NOTE

IF TRIM WARNING LIGHT STAYS ON THEN THE AUTOTRIM DID NOT PASS PREFLIGHT TEST. THE AUTOPILOT CIRCUIT BREAKER SHOULD BE PULLED. MANUAL ELECTRIC TRIM CAN NOT BE USED.

4. MANUAL ELECTRIC TRIM - TEST as follows:

   a. Actuate the left side of the split switch to the fore and aft positions. The trim wheel should not move on its own. Rotate the trim wheel manually against the engaged clutch to check the pilot's overpower capability.

   b. Actuate right side of split switch unit to the fore and aft positions. The trim wheel should not move on its own and normal trim wheel force is required to move it manually.

   c. Press the A/P DISC/TRIM INTER switch down and hold. Manual Electric Trim should not operate either nose up or nose down.

5. FLIGHT DIRECTOR (KFC 150 ONLY) - ENGAGE by pressing FD or CWS button.

6. AUTOPILOT - ENGAGE by pressing AP ENG button.

7. CONTROL WHEEL - MOVE fore, aft, left & right to verify that the autopilot can be over-powered.

8. A/P DISC/TRIM INTER Switch - PRESS. Verify that the autopilot disconnects and all flight director modes are canceled.

9. TRIM - SET to take off position.

B. AUTOPILOT OPERATION

1. Before takeoff

a. A/P DISC/TRIM INTER Switch - PRESS.

2. Autopilot Engagement

a. FD Mode Selector Button (KFC 150 Only) - PRESS.

b. AP ENG Button - PRESS. Note AP annunciator on. If no other modes are selected the autopilot will operate in wings level and pitch attitude hold.

CAUTION

DO NOT HELP THE AUTOPILOT AS THE AUTOPILOT WILL RUN THE PITCH TRIM TO OPPOSE YOUR HELP.

3. Climb or Descent

a. Using CWS

1) CWS Button - PRESS and MOVE aircraft nose to the desired attitude.

2) CWS Button - RELEASE. Autopilot will maintain aircraft pitch attitude up to the pitch limits of $+15^{o}$ or -10^{o}.

b. Using Vertical Trim

1) VERTICAL TRIM Control - PRESS either up or down to modify aircraft attitude at a rate of .7 deg/sec. up to the pitch limits of $+15^{o}$ or -10^{o}.

2) VERTICAL TRIM Control - RELEASE when desired aircraft attitude is reached. The autopilot will maintain the desired pitch attitude.

4. Altitude Hold

a. ALT Mode Selector Button - PRESS. Note ALT mode annunciator ON. Autopilot will maintain the selected pressure altitude.

b. Change selected altitudes

1) Using CWS (recommended for altitude changes greater than 100 ft.)

a) CWS Button - PRESS and fly aircraft to desired pressure altitude.

b) CWS Button - RELEASE when desired pressure altitude is reached. The autopilot will maintain the desired pressure altitude.

2) Using Vertical Trim (Recommended for altitude changes less than 100 ft.)

a) VERTICAL TRIM Control - PRESS either up or down. Vertical Trim will seek an altitude rate of change of about 500 fpm.

b) VERTICAL TRIM Control - RELEASE when desired pressure altitude is reached. The autopilot will maintain the desired pressure altitude.

5. Heading Changes

a. Manual Heading Changes

1) CWS Button - PRESS and MANEUVER aircraft to the desired heading.

2) CWS Button - RELEASE. Autopilot will maintain aircraft in wings level attitude.

NOTE

AIRCRAFT HEADING MAY CHANGE IN THE WINGS LEVEL MODE DUE TO AN AIRCRAFT OUT OF TRIM CONDITION.

b. Heading Hold

1) Heading Selector Knob - SET BUG to desired heading.

2) HDG Mode Selector Button - PRESS. Note HDG mode annunciator ON. Autopilot will automatically turn the aircraft to the selected heading.

c. Command Turns (Heading Hold mode ON)

1) HEADING Selector Knob - MOVE BUG to the desired heading. Autopilot will automatically turn the aircraft to the new selected heading.

6. NAV Coupling

a. When equipped with HSI.

1) Course Bearing Pointer - SET to desired course.

NOTE

WHEN EQUIPPED WITH NAV 1/NAV 2 SWITCHING AND NAV 2 IS SELECTED, SET OBS TO THE DESIRED COURSE.

2) HEADING Selector Knob - SET BUG to provide desired intercept angle.

3) NAV Mode Selector Button - PRESS.

a) If the Course Deviation Bar is greater than 2 to 3 dots: the aircraft will continue in HDG mode (or wings level if HDG not selected) with the NAV annunciator flashing; when the computed capture point is reached the HDG will disengage, the NAV annunciator will illuminate steady and the selected course will be automatically captured and tracked.

b) If the D-Bar is less than 2 to 3 dots: the HDG mode will disengage upon selecting NAV mode; the NAV annunciator will illuminate steady and the capture/track sequence will automatically begin.

b. When equipped with DG

1) OBS Knob - SELECT desired course.

2) NAV Mode Selector Button - PRESS.

3) Heading Selector Knob - ROTATE BUG to agree with OBS course.

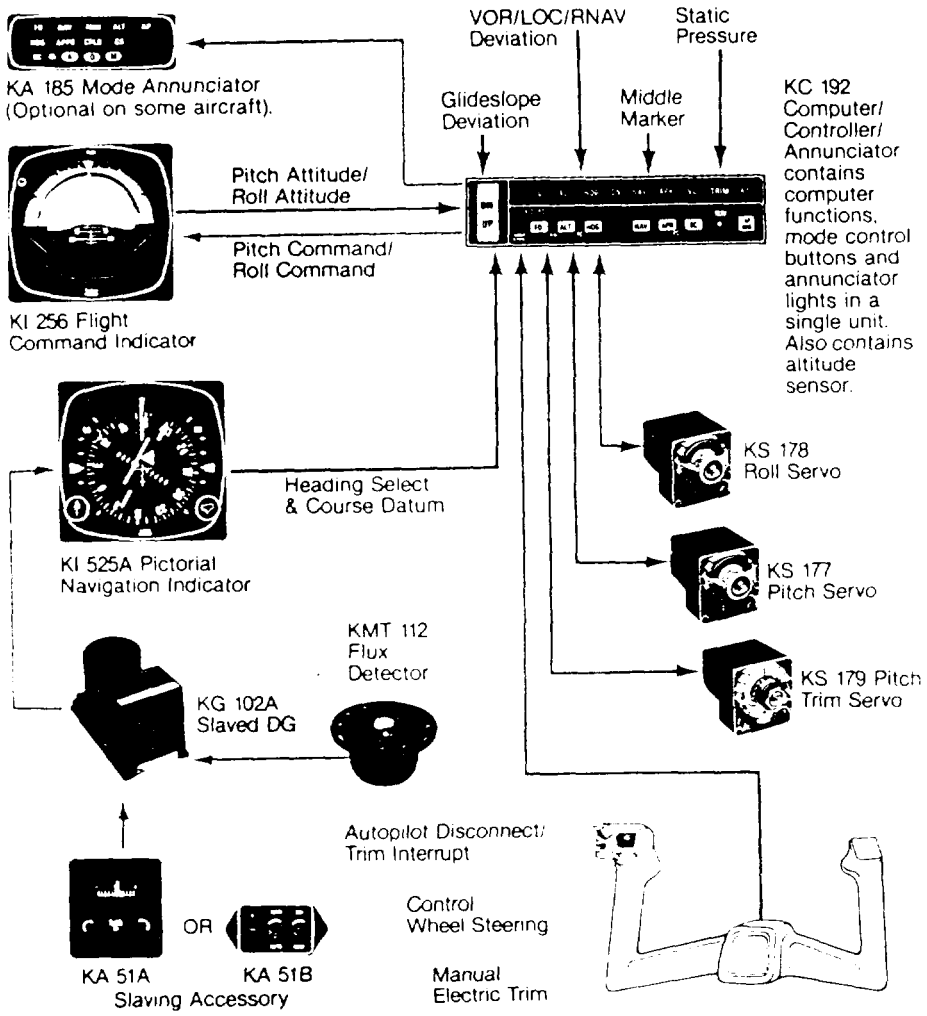
NOTE

WHEN NAV IS SELECTED, THE LATERAL OPERATING MODE WILL CHANGE FROM HDG (IF SELECTED) TO WINGS LEVEL FOR 5 SECONDS. A 45° INTERCEPT ANGLE WILL THEN BE AUTOMATICALLY ESTABLISHED BASED ON THE POSITION OF THE BUG.

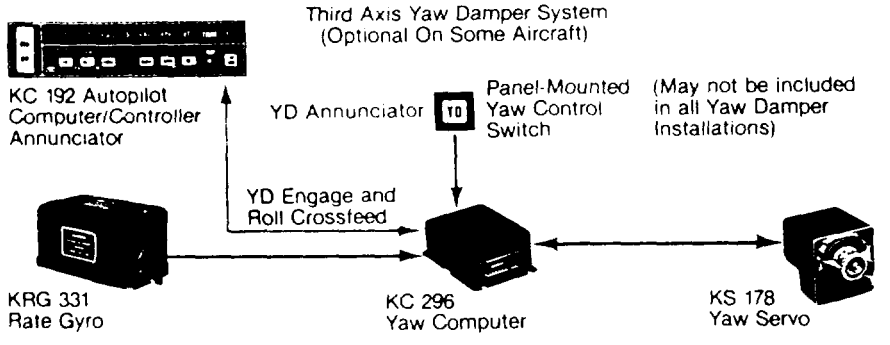
a) If the D-Bar is greater than 2 to 3 dots: the autopilot will annunciate HDG mode (unless HDG not selected) and NAV flashing; when the computed capture point is reached the HDG annunciator will go out, the NAV annunciator will illuminate steady and the selected course will be automatically captured and tracked.

b) If the D-Bar is less than 2 to 3 dots: the HDG mode will disengage upon selecting NAV mode; the NAV annunciator will illuminate steady and the capture/track sequence will automatically begin.

TYPICAL KFC 150 FLIGHT CONTROL SYSTEM



This Is A 2-Axis (Pitch and Roll) System.



KAP 150 KAP 100

C-26

SECTION I - GENERAL

The KLN 90B GPS panel mounted unit contains the GPS sensor, the navigation computer, a CRT display, and all controls required to operate the unit. It also houses the data base cartridge which plugs directly into the back of the unit.

The data base cartridge is an electronic memory containing information on airports, navaids, intersections, SID's, STAR's, instrument approaches, special use airspace, and other items of value to the pilot.

Every 28 days, Bendix/King receives new data base information from Jeppesen Sanderson for the North American data base region. This information is processed and downloaded onto the data base cartridges. Bendix/King makes these data base cartridge updates available to KLN 90B GPS users.

Provided the KLN 90B GPS navigation system is receiving adequate usable signals, it has been demonstrated capable of and has been shown to meet the accuracy specifications of:

VFR/IFR en route oceanic and remote, en route domestic, terminal, and instrument approach (GPS, Loran-C, VOR, VOR-DME, TACAN, NDB, NDB-DME, RNAV) operation within the U.S. National Airspace System, North Atlantic Minimum Navigation Performance Specifications (MNPS) Airspace and latitudes bounded by 74° North and 60° South using the WGS-84 (or NAD 83) coordinate reference datum in accordance with the criteria of AC 20-138, AC 91-49, and AC 120-33. Navigation data is based upon use of only the global positioning system (GPS) operated by the United States

NOTE

Aircraft using GPS for oceanic IFR operations may use the KLN 90B to replace one of the other approved means of long-range navigation. A single KLN 90B GPS installation may also be used on short oceanic routes which require only one means of long-range navigation.

NOTE

FAA approval of the KLN 90B does not necessarily constitute approval for use in foreign airspace.

SECTION II - LIMITATIONS

A. The KLN 90B GPS Pilot's Guide, P/N 006-08773-0000, dated December, 1994 (or later applicable revision) must be immediately available to the flight crew whenever navigation is predicated on the use of the system. The Operational Revision Status (ORS) of the Pilot's Guide must match the ORS level annunciated on the Self Test page.

B. IFR Navigation is restricted as follows:

1. The system must utilize ORS level 20 or later FAA approved revision.

2. The data on the self test page must be verified prior to use. Verify valid altitude data is available to the KLN 90B prior to flight.

3. IFR en route and terminal navigation is prohibited unless the pilot verifies the currency of the data base or verifies each selected waypoint for accuracy by reference to current approved data.

4. Instrument approaches must be accomplished in accordance with approved instrument approach procedures that are retrieved from the KLN 90B data base. The KLN 90B data base must incorporate the current update cycle.

   (a) The KLN 90B Memory Jogger, P/N 006-08785-0000, dated 12/94 (or later applicable revision) must be immediately available to the flight crew during instrument approach operations.

   (b) Instrument approaches must be conducted in the approach mode and RAIM must be available at the Final Approach Fix.

   (c) APR ACTV mode must be annunciated at the Final Approach Fix.

   (d) Accomplishment of ILS, LOC, LOC-BC, LDA, SDF, and MLS approaches are not authorized.

   (e) When an alternate airport is required by the applicable operating rules, it must be served by an approach based on other than GPS or Loran-C navigation.

   (f) The KLN 90B can only be used for approach guidance if the reference coordinate datum system for the instrument approach is WGS-84 or NAD-83. (All approaches in the KLN 90B data base use the WGS-84 or the NAD-83 geodetic datums.)

5. The aircraft must have other approved navigation equipment appropriate to the route of flight installed and operational.

SECTION III - EMERGENCY PROCEDURES
ABNORMAL PROCEDURES

A. If the KLN 90B GPS information is not available or invalid, utilize remaining operational navigation equipment as required.

B. If a "RAIM NOT AVAILABLE" message is displayed while conducting an instrument approach, terminate the approach. Execute a missed approach if required.

C. If a "RAIM NOT AVAILABLE" message is displayed in the en route or terminal phase of flight, continue to navigate using the KLN 90B or revert to an alternate means of navigation appropriate to the route and phase of flight. When continuing to use GPS navigation, position must be verified every 15 minutes using another IFR approved navigation system.

D. Refer to the KLN 90B Pilot's Guide, Appendices B and C, for appropriate pilot actions to be accomplished in response to annunciated messages.

SECTION IV - NORMAL PROCEDURES

WARNING

Familiarity with the en route operation of the KLN 90B does not constitute proficiency in approach operations. Do not attempt approach operations in IMC prior to attaining proficiency in the use of the KLN 90B.

A. OPERATION

Normal operating procedures are outlined in the KLN 90B GPS Pilot's Guide, P/N 006-08773-0000, dated December, 1994, (or later applicable revision). A KLN 90B Memory Jogger, P/N 006-08785-0000 dated 12/94 (or later applicable revision) containing an approach sequence, operating tips and approach related messages is intended for cockpit use by the KLN 90B familiar pilot when conducting instrument approaches.

SECTION IV
NORMAL PROCEDURES

WARNING

To prevent the possibility of turn anticipation causing potentially misleading navigation when the aircraft is not on course:

- **Verify the HSI course and D-BAR presentation is proper prior to takeoff.**
- **Do not switch from OBS to LEG with greater than 1 nm cross track error (XTK).**

If misleading data is suspected, a Direct-To operation to your desired waypoint will clear any previous OBS course, and cancel turn anticipation.

NOTES

- After the above Direct-To operation, further reorientation to the nearest leg of the active flight plan may be accomplished by pressing [D→], [CLR], [ENT].
- Refer to the Pilot's Guide section 4.2.2 for an explanation of turn anticipation, and Appen-dix A - Navigation Terms for the definition of cross track error (XTK).

B. SYSTEM ANNUNCIATORS/SWITCHES/CONTROLS

1. HSI NAV presentation (**NAV/GPS**) switch annunciator - May be used to select data for presentation on the pilot's HSI; either NAV data from the number one navigation receiver or GPS data from the KLN 90B GPS. Presentation on the HSI is also required for autopilot coupling. **NAV** is green. **GPS** is blue.

2. Message (**MSG**) annunciator - Will flash to alert the pilot of a situation that requires attention. Press the MSG button on the KLN 90B GPS to view the message. (Appendix B of the KLN 90B Pilot's Guide contains a list of all of the message page messages and their meanings). **MSG** is amber.

3. Waypoint (**WPT**) annunciator - Prior to reaching a waypoint in the active flight plan, the KLN 90B GPS will provide navigation along a curved path segment to ensure a smooth transition between two adjacent legs in the flight plan. This feature is called turn anticipation. Approximately 20 seconds prior to the beginning of turn anticipation the WPT annunciator will flash, going solid upon initialization of the turn, and extinguishing upon turn completion. **WPT** is amber.

WARNING

Turn anticipation is automatically disabled for FAF waypoints and those used exclusively in SID/STARS where overflight is required. For waypoints shared between SID/STARS and published en route segments (requiring overflight in the SID/STARS), proper selection on the presented waypoint page is necessary to provide adequate route protection on the SID/STARS.

4. GPS omni bearing or leg (**GPS CRS OBS/LEG**) course switch/annunciator - Used to select the basic modes of KLN 90B operation, either a) single waypoint with omni - bearing course (OBS) selection through that waypoint (like a VOR) or b) automatic leg sequencing (LEG) between waypoints. **GPS CRS** is white. **OBS** may either be white or amber. **LEG** is green.

NOTE

Either **LEG** or **OBS** will illuminate during system self test depending upon switch position.

5. At or before 2 nm from the FAF inbound:

   a. Select the FAF as the active waypoint, if not accomplished already.
   b. Select LEG operation.

6. Approaching the FAF inbound (within 2 nm.):

   a. Verify APR **ACTV**.
   b. Note automatic dbar scaling change from ± 1.0 nm to ± 0.3 nm over the 2 nm inbound to the FAF.
   c. Internally the KLN 90B will transition from terminal to approach integrity monitoring.

7. Crossing the FAF and APR **ACTV** is not annunciated:

   a. Do not descend.
   b. Execute the missed approach

8. Missed Approach:

   a. Climb
   b. Navigate to the MAP (in APR **ARM** if APR **ACTV** is not available).

NOTE

There is no automatic **LEG** sequencing at the MAP.

   c. After climbing in accordance with the published missed approach procedure, press [-D-], verify or change the desired holding fix and press **ENT**.

GENERAL NOTES

- The data base must be up to date for instrument approach operation.
- Only one approach can be in the flight plan at a time.
- Checking RAIM prediction for your approach while en route using the **STA 5** page is recommended. A self check occurs automatically within 2nm of the FAF. APR **ACTV** is inhibited without RAIM.

SECTION IV
NORMAL PROCEDURES

3. At 30 nm from the FAF:

   a. Verify automatic annunciation of APR **ARM**.
   b. Note automatic dbar scaling change from ± 5.0nm to ± 1.0 nm over the next 30 seconds.
   c. Update the KLN 90B altimeter baro setting as required.
   d. Internally the KLN 90B will transition from en route to termina integrity monitoring.

4. Select Super **NAV** 5 page to fly the approach procedure.

   a. If receiving radar vectors, or need to fly a procedure turn or holding pattern, fly in **OBS** until inbound to the FAF.

NOTE

OBS navigation is TO-FROM (like a VOR) without waypoint sequencing.

WARNING

To prevent the possibility of turn anticipation causing potentially misleading navigation when the aircraft is not on course, do not switch from OBS to LEG with greater than 1 nm cross track error (XTK).

   b. **NoPT** routes including DME arc's are flown in **LEG**. LEG is mandatory from the FAF to the MAP.

NOTE

Select HDG mode for DME arc intercepts. NAV or APR coupled DME arc intercepts can result in excessive overshoots (aggravated by high ground speeds and/or intercepts from inside the arc).

WARNING

Flying final outbound from an off-airport vortac on an overlay approach; beware of the DME distance increasing on final approach, and the GPS distance-to-waypoint decreasing, and not matching the numbers on the approach plate!

SECTION IV
NORMAL PROCEDURES

5. HSI course control knob - Provides analog course input to the KLN 90B in **OBS** when the NAV/GPS switch/annunciator is in **GPS**. When the NAV/GPS switch annunciation is in **NAV**, GPS course selection in **OBS** mode is digital through the use of the controls and display at the KLN 90B. The HSI course control knob must also be set to provide proper course datum to the autopilot if coupled to the KLN 90B in LEG or OBS.

NOTE

Manual HSI course centering in **OBS** using the control knob can be difficult, especially at long distances. Centering the dbar can best be accomplished by pressing [CDI] and then manually setting the HSI pointer to the course value prescribed in the KLN 90B displayed message.

6. GPS approach (**GPS APR ARM/ACTV**) switch/annunciator - Used to a) manually select or deselect approach **ARM** (or deselect approach **ACTV**) and b) annunciate the stage of approach operation either armed (ARM) or activated (ACTV). Sequential button pushes if in **ACTV** would first result in approach **ARM** and then approach arm canceled. Subsequent button pushes will cycle between the armed state (if an approach is in the flight plan) and approach arm canceled. Approach **ACTV** cannot be selected manually. **GPS APR** and **ARM** are white. **ACTV** is green.

7. RMI NAV presentation switch - May be used to select data for presentation on the RMI; either NAV 2 data from the number two navigation receiver, or GPS data from the KLN 90B GPS.

C PILOT'S DISPLAY

Left/right steering information is presented on the pilot's HSI as a function of the NAV/GPS switch position.

D AUTOPILOT COUPLED OPERATION

The KLN 90B may be coupled to the autopilot by first selecting **GPS** on the NAV/GPS switch. Manual selection of the desired track on the pilot's HSI course pointer is required to provide course datum to the autopilot. (Frequent manual course pointer changes may be necessary, such as in the case of flying a DME arc.) The autopilot approach mode (**APR**) should be used when conducting a coupled GPS approach.

NOTE

Select HDG mode for DME arc intercepts. NAV or APR coupled DME arc intercepts can result in excessive overshoots (aggravated by high ground speeds and/or intercepts from inside the arc).

E. APPROACH MODE SEQUENCING AND RAIM PREDICTION

NOTE

The special use airspace alert will automatically be disabled prior to flying an instrument approach to reduce the potential for message congestion.

1. Prior to arrival, select a STAR if appropriate from the **APT 7** page. Select an approach and an initial approach fix (IAF) from the **APT 8** page.

NOTES

- Using the right hand outer knob, select the **ACT** (Active Flight Plan Waypoints) pages. Pull the right hand inner knob out and scroll to the destination airport, then push the inner knob in and select the **ACT 7** or **ACT 8** page.

- To delete or replace a SID, STAR or approach, select **FPL 0** page. Place the cursor over the name of the procedure, press **ENT** to change it, or **CLR** then **ENT** to delete it.

2. En route, check for RAIM availability at the destination airport ETA on the **STA 5** page.

NOTE

RAIM must be available at the FAF in order to fly an instrument approach. Be prepared to terminate the approach upon loss of RAIM.

SECTION IV
NORMAL PROCEDURES

- Data cannot be altered, added to or deleted from the approach procedures contained in the data base. (DME arc intercepts may be relocated along the arc through the **SUPER NAV 5** or the **FPL 0** pages).

- **Some approach waypoints do not appear on the approach plates (including in some instances the FAF)!**
- Waypoint suffixes in the flight plan:

  i - IAF
  f - FAF
  m - MAP
  h - missed approach holding fix.

- The DME arc IAF (arc intercept waypoint) will be a) on your present position radial off the arc VOR when you load the IAF into the flight plan, or b) the beginning of the arc if currently on a radial beyond the arc limit. To adjust the arc intercept to be compatible with a current radar vector, bring up the arc IAF waypoint in the **SUPER NAV 5** page scanning field or under the cursor on the **FPL 0** page, press **CLR**, then **ENT**. Fly the arc in LEG, adjust the HSI or CDI course pointer with reference to the desired track value on the **SUPER NAV 5** page (it will flash to remind you). Left/right dbar information is relative to the arc. Displayed distance is not along the arc but direct to the active waypoint. If desired, select **NAV 2** page for digital DME arc distance to and radial from the reference VOR. (The **ARC** radial is also displayed on the **SUPER NAV 5** page.)

- The DME arc IAF identifier may be unfamiliar. Example: D098G where 098 stands for the 098° radial off the referenced VOR, and G is the seventh letter in the alphabet indicating a 7 DME arc.

- APR **ARM** to APR **ACTV** is automatic provided:

  a. You are in APR **ARM** (normally automatic).
  b. You are in **LEG** mode!
  c. The **FAF** is the active waypoint!
  d. Within 2 n.m. of the FAF.
  e. Outside of the FAF.
  f. Inbound to the FAF.
  g. RAIM is available.

- Direct-To operation between the FAF and MAP cancels APR **ACTV**. Fly the missed approach in APR **ARM**

- Flagged navigation inside the FAF may usually be restored (not guaranteed) by pressing the GPS APR button changing from **ACTV** to **ARM**. Fly the missed approach.

- The instrument approach using the KLN 90B may be essentially automatic starting 30 nm out (with a manual baro setting update) or it may require judicious selection of the OBS and LEG modes.

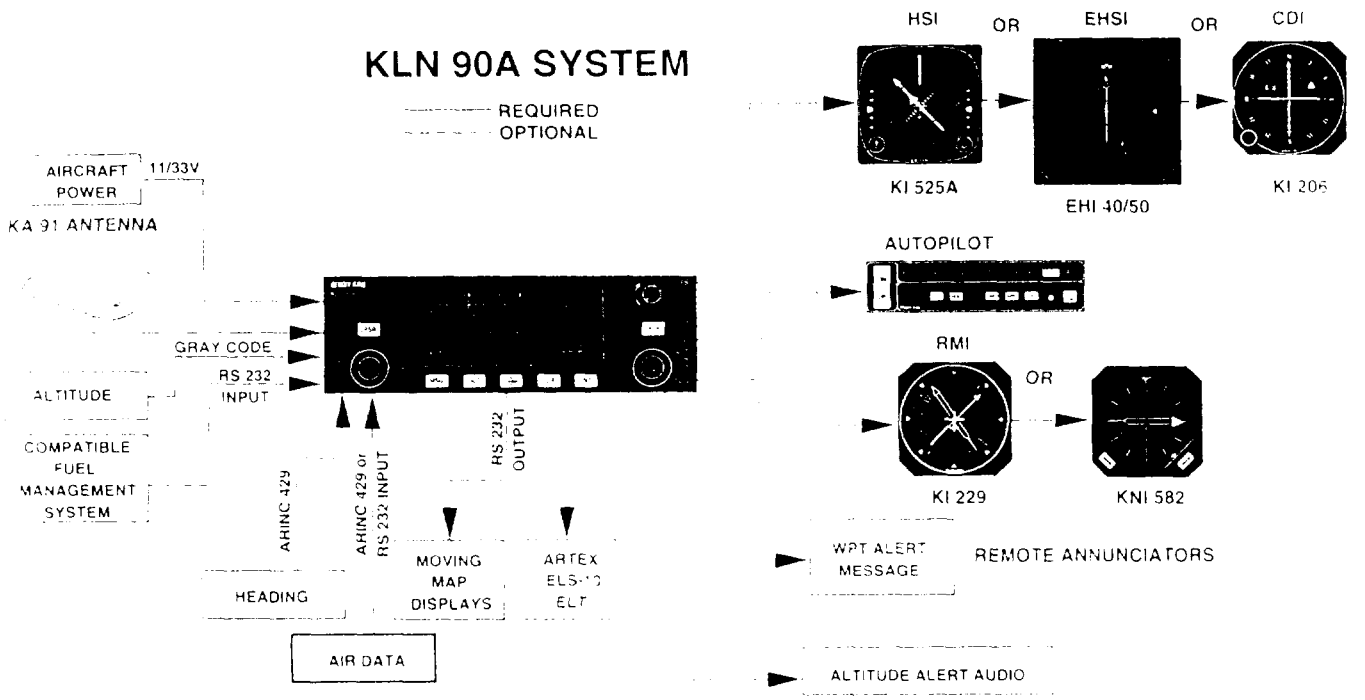
- APR **ARM** may be canceled at any time by pressing the GPS APR button. (A subsequent press will reselect it.)

SECTION V - PERFORMANCE

No change.

CHAPTER 1 - KLN 90A SYSTEM COMPONENTS

A basic KLN 90A system consists of a panel mounted KLN 90A GPS sensor/navigation computer, a data base cartridge, and an antenna. An altitude input is required to obtain full navigation and operational capabilities. Additional system components may be added or interfaced to the KLN 90A which increase its features and capabilities. Some of these optional components include an external course deviation indicator (CDI), or HSI, RMI, fuel management system, air data system, ARTEX ELS-10 emergency locator transmitter (ELT), autopilot, and external annunciators.



The KLN 90A panel mounted unit contains the GPS sensor, the navigation computer, a CRT display, and all controls required to operate the unit. It also houses the data base cartridge which plugs directly into the back of the unit.

The data base cartridge is an electronic memory containing a vast amount of information on airports, navaids, intersections, special use airspace, and other items of value to the pilot. The data base is designed to be easily updated by the user by using a laptop computer and Bendix/King furnished 3.5 inch diskettes. The data base may also be updated by removing the obsolete cartridge and replacing it with a current one.

C-38