

United States Army Warfighting Center
Fort Rucker, Alabama
OCTOBER 2006



STUDENT HANDOUT

TITLE: CH-47D FLIGHT INSTRUMENT SYSTEM

FILE NUMBER: 011-2101-3

PROPONENT FOR THIS STUDENT HANDOUT IS:

110th Aviation Training Brigade
ATTN: ATZQ-ATB-AD
Fort Rucker, Alabama 36362-5000

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CH-47D FLIGHT INSTRUMENTS

STUDENT HANDOUT

TERMINAL LEARNING OBJECTIVE (TLO):

Action: Describe operational characteristics, functions and limitations of selected CH-47D Flight Instruments.

Conditions: In a classroom, given a CH-47D Flight Instrument Trainer, and a student handout.

Standards: Correctly answer in writing, without reference, five of seven questions pertaining to the operational characteristics, limitations, and functions or malfunctions of the CH-47D Flight Instruments, In Accordance With (IAW) TM 1-1520-240-10 and the student handout.

Safety Requirements: None.

Risk Assessment Level: Low.

Environmental Considerations: None.

Evaluation: Each student will be evaluated on this block of instruction during the first written examination. This will be a criterion type examination requiring a GO on each scored unit. You will have 90 minutes for the exam.

1. **Learning Step/Activity 1-Describe operational characteristics and functions of the Horizontal Situation Indicator (HSI).**
 - a. Horizontal Situation Indicators (HSI).



- (1) Located on the instrument panel.
 - (a) Pilot.
 - (b) Copilot.



- (2) Each indicator can display the following.
 - (a) Helicopters present heading.
 - (b) Frequency modulated homing.
 - (c) A position relative to a selected course or bearing.
 - (d) Position relative to the glide slope and localizer, during Instrument Landing System approaches (ILS).
- (3) Controls the heading select feature of the Advanced Flight Control System (AFCS).
- (4) Selection of the navigational equipment to be displayed on each HSI is controlled through the HSI MODE SELECT panel on each instrument panel.

b. Controls and indicators.

- (1) Compass card.
 - (a) Turns to display heading data obtained from the gyro magnetic compass (directional gyro – DG).
 - (b) The present helicopter heading is read at the lubber line.

(2) Bearing pointer No.1.



- (a) Operates in conjunction with Doppler or GPS.
 - (b) Indicates the bearing to the Doppler or GPS waypoint selected by the pilots.
- (3) Bearing pointer No.2.
- (a) Operates in conjunction with the VHF Omni-directional Range (VOR) or Automatic Direction Finder (ADF).
 - (b) The pointer is read against the compass card.
 - (c) Indicates the bearing to the VOR or ADF station.
- (4) Course Deviation Indicator (CDI).
- (a) This needle indicates your lateral deviation from a selected course.
 - (b) When the helicopter is flying the selected course, the CDI will be aligned with the course pointer and will also be centered on the fixed aircraft symbol.
 - (c) The dots on either side of the CDI indicate amount of course deviation.
 - 1) One dot displacement is equal to –
 - a) Five degrees off VOR or Doppler.
 - b) One and one-fourth degrees off a localizer course.
 - 2) Dot displacement does not apply to FM homing.
- (5) Course (CRS) select knob.



- (a) This is used to select your desired course.
 - (b) Operates in conjunction with the course pointer and course indicator.
 - (c) The COURSE indicator (digital) displays the course selected.
 - (d) Once set, the course pointer will turn with the compass card and will be aligned with the lubber line when the helicopter heading is the same as the selected course.
- (6) The RANGE indicator in the upper left hand corner of the HSI displays distance to a waypoint in kilometers, from either the Doppler or GPS.
- (7) Heading (HDG) select knob.
- (a) Operates in conjunction with the heading bug to allow the pilot to set a heading.
 - (b) AFCS will turn the aircraft to the selected heading when:
 - 1) CMD SEL is engaged on the HSI MODE SELECT panel.
 - 2) HDG is engaged on the AFCS control panel.
- (8) Heading flag (HDG) will be visible when:



- (a) The signal from the gyro compass is unreliable.
 - (b) Power to the indicator is lost.
- (9) The To-From arrow indicates the aircraft is flying to or away from a selected VOR or station passage.
- (10) Navigation flag (NAV).
- (a) It is positioned within the compass card and turns when the compass card turns.
 - (b) The flag will retract from view when a reliable VOR, GPS/Doppler, or FM homing signal is applied to the instrument.
- (11) The fixed aircraft symbol corresponds to the longitudinal axis of the helicopter and shows position and heading relative to the selected course.
- (12) Glide slope pointer.
- (a) Displays glide slope position relative to the helicopter.
 - (b) When the pointer is above center, the aircraft is below glide slope. When the pointer is below center, the aircraft is above glide slope.
 - (c) If using FM homing, the pointer rises with signal strength and falls with decreasing signal strength.

c. HSI MODE SELECT panel.



(1) Located directly below each HSI.



(2) The switches are push-ON type buttons and when pressed, will illuminate.

(3) Course section.

(a) The course section consists of four switches.

(b) Pressing VOR SEL, GPS/DOP SEL, or FM SEL causes the output of the selected navigation set to be electrically connected to the course deviation indicator (CDI) on the HSI.

1) These switches are electrically interlocked.

2) Only one mode may be selected at a time.

- 3) Selecting another navigational mode will turn off the mode in use and engage the newly selected mode.
 - (c) CMD SEL selects the HSI to be used for AFCS heading select.
- (4) Bearing section (BRG).
 - (a) There is only one switch in this section and it is labeled as VOR/ADF.
 - (b) Affects **only** the No. 2 bearing pointer on that HSI.
 - (c) If the VOR segment is lit, the No. 2 pointer will indicate the bearing to the VOR station to which the VHF navigation set is tuned.
 - (d) Pressing the switch will cause the VOR segment light to go out.
 - (e) The No. 2 pointer will now indicate the bearing to the station to which the ADF set is tuned and the ADF light will illuminate.
 - (f) Pressing the switch a second time will cause the opposite action.



- (5) Marker Beacon (MKR BCN) lights.
 - (a) A light will come on when passing through the markers.
 - 1) "O" light.
 - a) Glows blue-green when passing through the marker.
 - b) 400 Hz tone will be heard through the interphone.
 - 2) "M" light.
 - a) Glows blue-green when passing the middle marker.
 - b) 1,300 Hz tone will be heard through the interphone.

- 3) "1" light.
 - a) Glows blue-green when passing the inner marker.
 - b) 3,000 Hz tone will be heard through the interphone.
- (b) The lights have a press to test feature. Pressing any one of the three lights and holding it, will cause all marker beacon lamps to light. Also, pressing the VOR/MB test switch on the VOR receiver will cause the beacon lamps to light.

2. Learning Step/Activity 2—Describe operational characteristics and functions of the Radar Altimeters.



a. Radar altimeters.

- (1) Two antennas, one for receive and one for transmit, are under the nose.



- (2) The radar altimeters are located on the pilot and copilot instrument panels.

(3) Purposes.

- (a) Provides an indication of the aircraft altitude above the surface from 0 to 1,500 feet.
- (b) The pilot's radar altimeter provides the signal to the No.1 AFCS computer for radar altitude hold.



- (4) Indicator display.
 - (a) Analog.
 - (b) Digital.
- (5) LO SET knob.
 - 1) Pilot's or copilot's applies power to the system.
 - 2) Can be set independently on each altimeter.
 - 3) Positions the LO SET index.
 - 4) Both LO SET indexes must be masked to turn the set off.
- (6) HI SET knob.
 - (a) Positions the HI SET index.
 - (b) Push this knob to test the system.
- (7) Caution lights.
 - (a) LO, comes on when the helicopter descends below the altitude set on the LO SET index.
 - (b) HI, comes on when the helicopter rises above the altitude set on the HI SET index.
- (8) The OFF flag is displayed when power is removed from the set or it is unreliable.
- (9) RAD ALT dimming controls.
 - (a) A rheostat type knob is located on the right side of each instrument panel.
 - (b) This knob controls light intensity.

b. Limitations.

- (1) If the aircraft exceeds:
 - (a) 1,500 feet.
 - (b) 45 degrees of pitch or roll.
- (2) The following will occur:
 - (a) OFF flag appears.
 - (b) The pointer will move through 1,500 feet behind the dial mask.
 - (c) The digital and index set lights will go out.

c. Normal operating procedures.

NOTE: The instructor will explain the current –10 procedures.

Pg:

(1) Starting.



(2) Testing.

(a) Pushing the PUSH-TO-TEST knob will cause the pointer and digital display to indicate Between 900 and 1,100 feet.

(b) If LO set and HI set are indexed below 900 feet, the LO caution light goes out, and the HI caution light comes on.

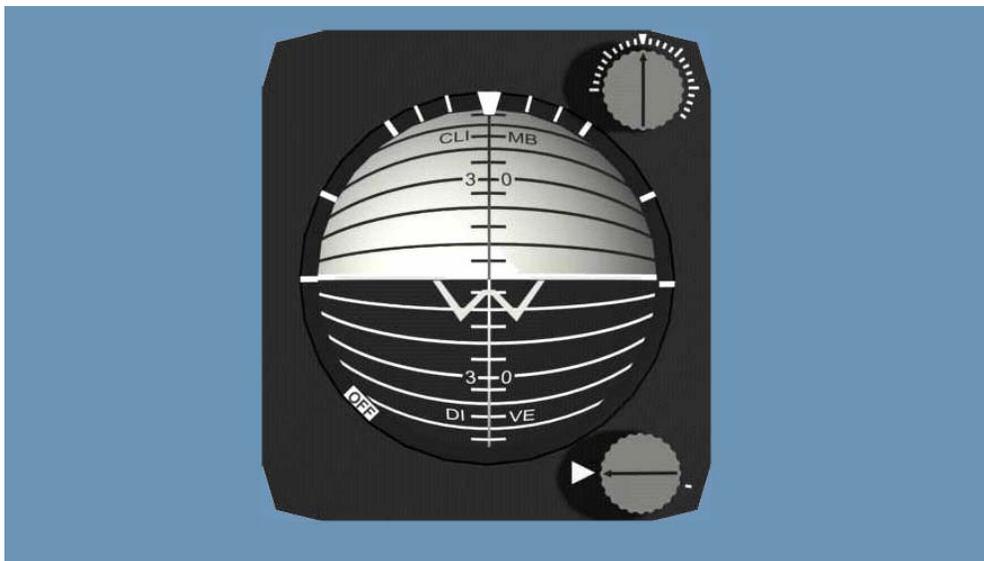
(3) In-flight operation.

(4) Shutdown.

3. Learning Step/Activity 3—Describe the functions, operational characteristics, and limitations of the Attitude Indicators.

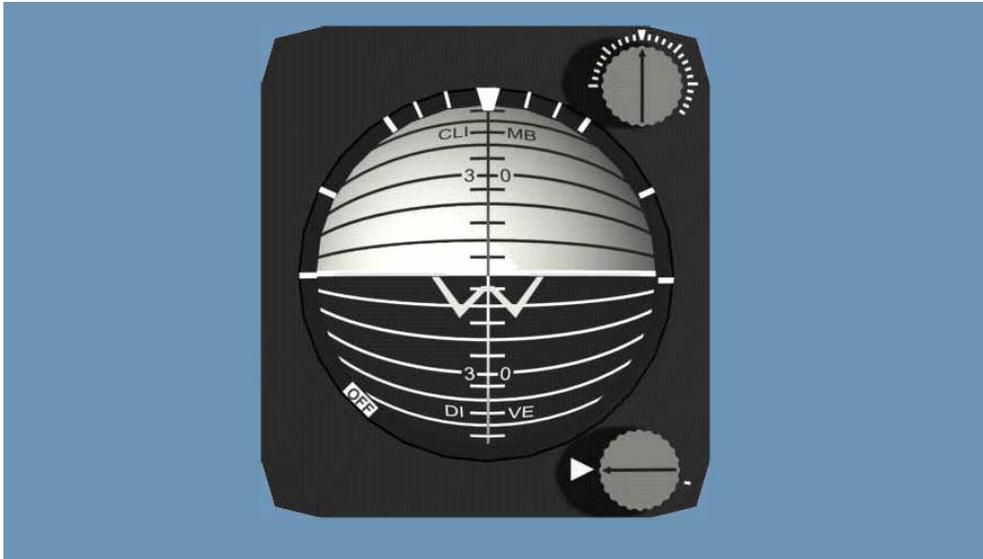


- a. Attitude indicators.
 - (1) The indicators are located on the pilot's and copilot's instrument panels.
 - (2) Indicates degrees of pitch and roll.
 - (3) Pitch and roll signal are received from:
 - (a) Copilot's vertical gyro, for the copilot's indicator.
 - (b) Pilot's vertical gyro, for the pilot's indicator.
 - (4) Trim knobs. The trim knobs are used to trim the indicator for normal flight attitudes, whether in-flight or on the ground.



- (a) Upper knob.

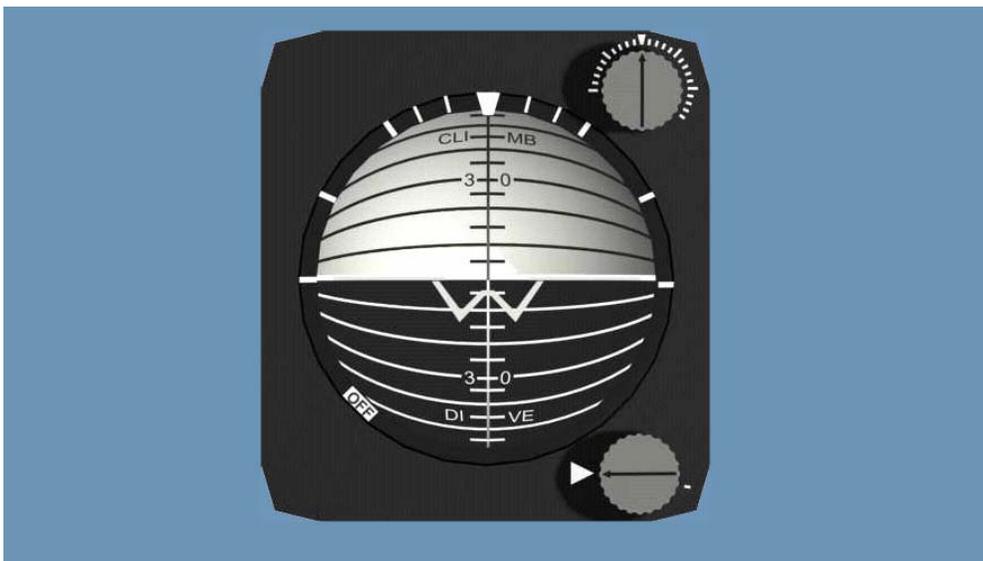
- 1) Controls the roll axis.
- 2) The adjustment range is 8 degrees left or right.



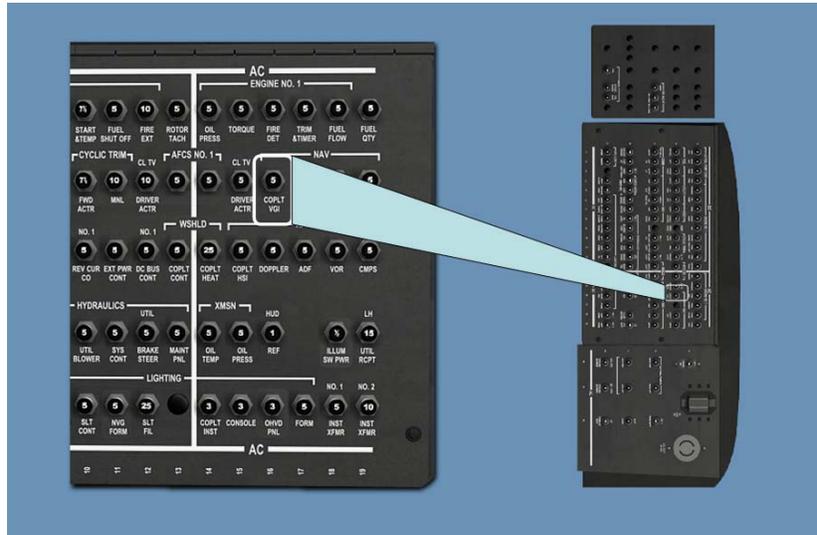
(b) Lower knob.

- 1) Controls the pitch axis.
- 2) The adjustment range is 20 degrees up or down.

OPERATOR'S MANUAL NOTE: Rapid rotation of the pitch and roll trim knobs on the attitude indicator may cause abrupt pitch and roll attitude changes with AFCS on.



- (5) The OFF flag indicates a failure of the associated vertical gyro or loss of power to the attitude indicator.
- (6) Electrical power requirements.
 - (a) Pilot's indicator – No.2 AC bus through the pilot VGI circuit breaker.



- (b) Copilot's indicator – No.1 AC bus through the COPLT VGI circuit breaker.
- (c) Both indicators should erect within 30 to 90 seconds after power is applied.

b. Pilot and copilot VGI switches.

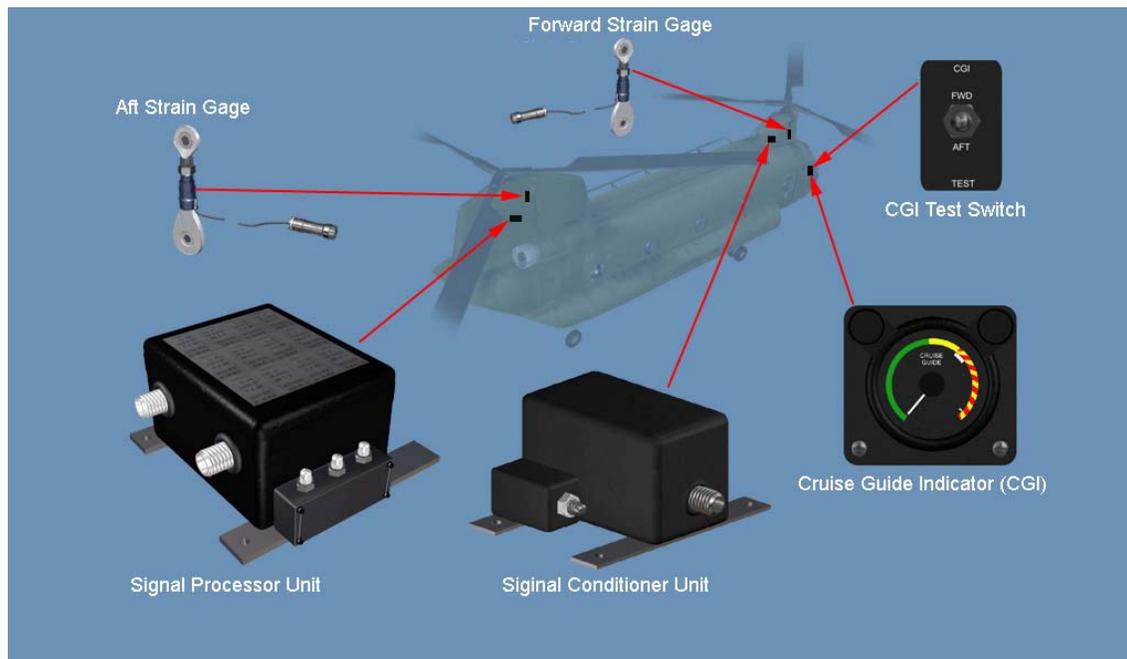


- (1) The switches are located on each instrument panel below each attitude indicator.
- (2) In the **NORM** position, each attitude indicator operates from a separate gyro.
- (3) **EMER** position.
 - (a) Use this position when a **gyro** fails.
 - (b) Switches the indicator to the remaining gyro.

NOTE: Failure of a gyro will result in a failure of the associated AFCS!

4. Learning Step/Activity 4—Describe the functions, characteristics, and limitations of the Cruise Guide Indicating System.

- a. Cruise Guide Indicating (CGI) system.



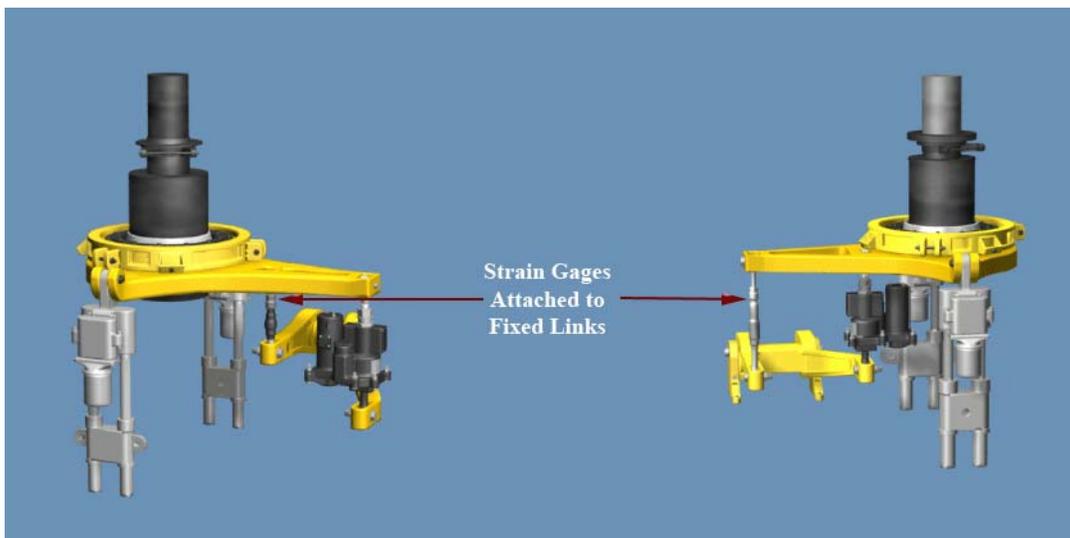
- (1) Provides the pilots with a visual indication of actual stress loads imposed on critical components.
- (2) Allows maximum utilization of the helicopter under various conditions of weight, altitude, airspeed, and center of gravity.
- (3) The CGI may be used to determine the maximum airspeed (V_{ne}) when the Longitudinal Cyclic Trim (**LCT**) is programmed, not to exceed 170 knots.

- b. Cruise Guide Indicator (CGI).



- (1) The needle should be kept in the green band.
- (2) Transient needle excursions into the yellow band are permissible but should be minimized.
- (3) Needle excursions into the red/yellow band are to be avoided.
 - (a) Immediate corrective action must be taken to reduce stress.
 - (b) This can be accomplished by lowering the thrust, reducing airspeed, reducing the severity of the maneuver, or by landing.

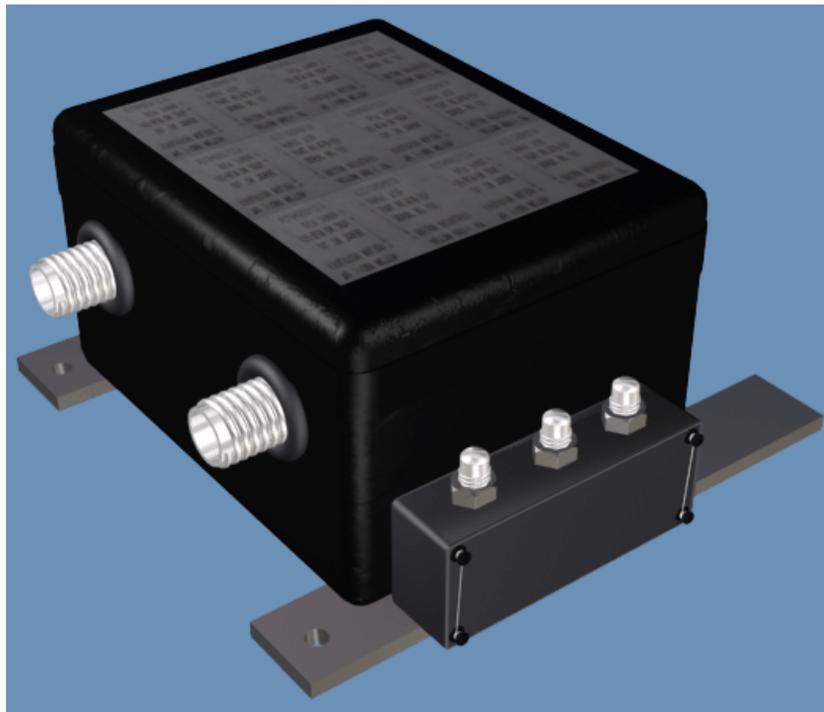
c. Strain-gages.



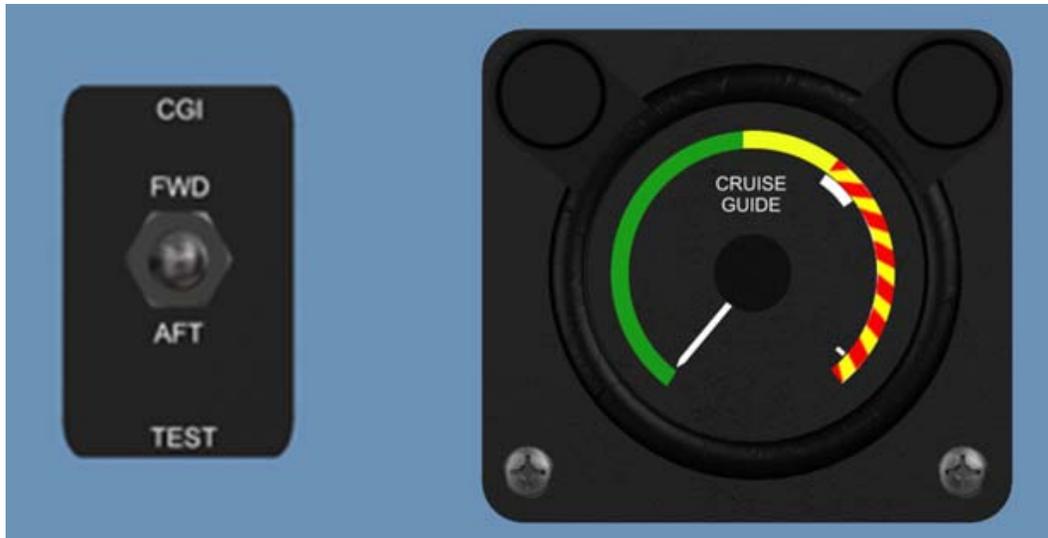
- (1) Location – bonded to the fixed link of the LCT system on the forward and aft upper controls.
- (2) Purpose – to generate signals that are proportional to stress loads.



- d. The Signal Conditioner Unit receives the signal from the forward strain gage and routes it to the Signal Processor Unit.



- e. The Signal Processor Unit receives and amplifies the signals from the Signal Conditioner Unit and the aft strain gage. The higher amplitude signal is then directed to the cockpit indicator.



- f. CGI test switch.
 - (1) Used to self-test the serviceability of the circuits.
 - (2) Testing.
 - (a) There are two test positions, FWD and AFT.
 - (b) The indicator pointer should move to the white band at each position.
 - (c) Do not test with the rotors turning, as false indications can result.
- g. Limitations.
 - (1) Flight at or below **98%** RRPM with an inoperative cruise guide indicator is prohibited.
 - (2) Airspeed limitations (Vne) will be determined by the use of the chart in Chapter 5, **Page 5-13**.
 - (3) Airspeed limitations (Vne) with **retracted LCT's** will be determined by the use of the chart in Chapter 5, **Page 5-14**.

Appendix C - Practical Exercises and Solutions

CH-47D FLIGHT INSTRUMENTS

PRACTICAL EXERCISE

NOTE: This practical exercise covers the instruction you received in this handout. Completion is optional but strongly encouraged!

1. What does the No.1 bearing pointer on the horizontal situation indicator (HSI) indicate?
2. What does the No.2 bearing pointer on the HSI indicate?
3. When may the cruise guide indicator be used to determine the maximum allowable airspeed (Vne)?
4. Which knob on the HSI operates the heading bug?
5. When will the heading HDG flag be in view?
6. What does the attitude indicator OFF Flag indicate?
7. May each pilot select a different navigational mode for display on his own HSI?
8. Which switches on the HSI MODE SELECT panel affect the No.2 bearing pointer?
9. With power applied both attitude indicators should erect within _____ to _____ seconds
10. When will the marker beacon lights come on the HSI MODE SELECT panel illuminate?
"O" light _____
"M" light _____
"I" light _____
11. What are the limitations for the radar altimeters?
Altitude—
Pitch and roll—
12. For testing of the radar altimeter where should the low index and high index be set?
13. What indications will you have that the radar altimeter limitations have been exceeded?

14. What is the purpose of the vertical gyro indicator (VGI) switches?
15. What two visual indications should you get with the failure of a vertical gyro?
16. What rotor RPM must you use if the cruise guide indicator is inoperative?
17. What are the underlined emergency procedure step(s) for a LCT failure?
18. What is one dot displacement on either side of the CDI equal to when operating in VOR or Doppler/GPS?
19. Testing the cruise guide system with the rotors turning will result in what?
20. What may rapid rotation of the pitch and roll trim knobs of the attitude indicator cause with AFCS on?

CH-47D FLIGHT INSTRUMENTS
PRACTICAL EXERCISE SOLUTIONS

1. Bearing to the doppler or GPS waypoint.
2. Bearing to the VOR or ADF station.
3. Only when the LCT's are Functional or with Programmed LCT's
- 4 HDG.
5. When the power to the indicator is lost or the signal from the gyro compass is unreliable.
6. Failure of associated vertical gyro or loss of power to the indicator
- 7 Yes.
8. VOR and ADF.
9. 30 to 90
10. O When passing through the outer marker.
M When passing over a middle marker.
I When passing over an inner marker.
11. Altitude – 1,500 feet.
Pitch and roll – 45 degrees.
12. Low at 100 Feet, and High at 800 Feet
13. OFF flag appears, pointer passes through 1,500 feet and the lights go out.
14. To switch the VGI to the opposite gyro when that gyro fails.
15. Off Flag on the failed gyro indicator, AFCS caution light
16. Above 98%.
17. Airspeed – Adjust.
18. 5 degrees off VOR or Doppler 1¼ Degrees off localizer course.
19. False indications.
20. Abrupt pitch and roll attitude changes OR un-commanded inputs into the flight controls.

