NAVAL AIR TRAINING COMMAND

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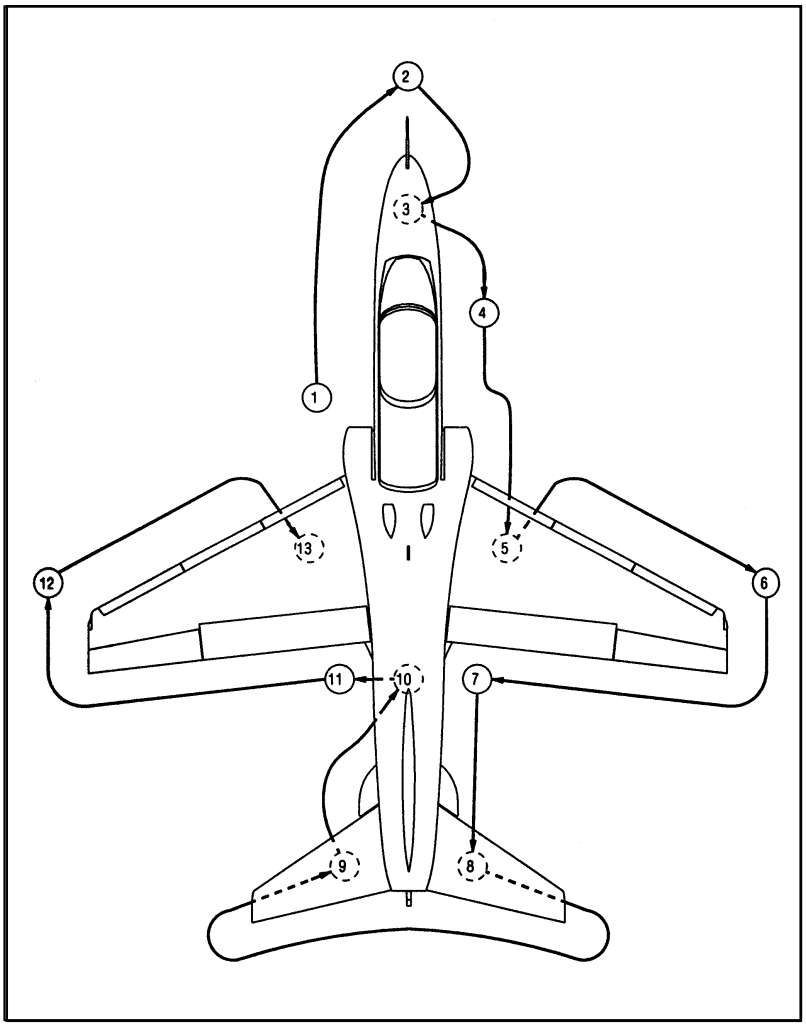
COCKPIT ORIENTATION



LESSON/LECTURE GUIDE

1999

T-45C FLIGHT SUPPORT LESSON GUIDE

CHANGE SUMMARY PAGE

CHANGE NUMBER	DATE ENTERED	CHANGE DESCRIPTION	INITIALS
1	10/05/01	Incorporated	TSC
2	04/11/06	Incorporated	TSC

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FLIGHT SUPPORT LESSON GUIDE
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LESSON GUIDE

COURSE/STAGE: TS, ADV, & IUT/Cockpit Orientation

LESSON TITLE: Exterior Preflight Checks

LESSON IDENTIFIER: T-45C TS, ADV, & IUT CO-01

LEARNING ENVIRONMENT: CAI

ALLOTTED LESSON TIME: .6 hr

TRAINING AIDS:

* Figures
  - Fig 1: Preflight/Daily/Turnaround/Postflight Maintenance Record
  - Fig 2: Aircraft Inspection And Acceptance Record (A Sheet)
  - Fig 3: Pink/Yellow Gripe Sheet
  - Fig 4: Typical Aircraft Form Sequence
  - Fig 5: Preflight Inspection Path

STUDY RESOURCES:

* T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

LESSON PREPARATION:

* Part III, Chapter 7, "Shore-Based Procedures," T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

REINFORCEMENT: N/A

EXAMINATION: N/A

(10-99) CHANGE 2

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LESSON OBJECTIVES

1.3.4.1.1
Observe preflight inspection

MOTIVATION

A thorough aircraft preflight inspection can be critical to flight safety and mission completion. Because it is your last chance to inspect the aircraft for integrity and proper servicing before flight, you need to allow sufficient time to complete a thorough preflight with the aid of the pocket checklist.

OVERVIEW

This lesson will reacquaint you with the aircraft discrepancy log books and present the exterior preflight inspection for the T-45C.

This lesson will cover:

* Aircraft maintenance record inspection
* Aircraft external preflight inspection

REFRESHER

* Recall the procedures for completing T-34 aircraft maintenance forms

PRESENTATION

I. Preflight inspection **1.3.4.1.1**

A. Aircraft maintenance records

1. Preflight/Daily/Turnaround/Postflight Maintenance Record (OPNAV Form 4790/38)

NOTE: The Preflight/Daily/Turnaround/ Postflight Maintenance Record (Figure 1), the first form in the Aircraft Discrepancy Book (ADB), lists inspection items performed by the plane captain at specific intervals as indicated on the form. Verify that all discrepancies have been corrected and signed off.

Fig 1: *Preflight/Daily/ Turnaround/Postflight Maintenance Record*

2. Aircraft Inspection and Acceptance Record (OPNAV Form 4790/141)

NOTE: The remainder of the Aircraft Discrepancy Book consists of the Aircraft Inspection and Acceptance Records ("A sheets," Figure 2) and associated gripe sheets (if any) from the last 10 flights (most recent flight first). The Aircraft Inspection and Acceptance Record serves as a record of inspection (maintenance and your preflight inspection) and also indicates your acceptance of the aircraft for flight. When safety of flight maintenance and plane captain inspections from the previous flight have been completed, this form is signed by the plane captain (block 9) and maintenance control (block 10). You will sign in block 11 to indicate your acceptance of the aircraft. An "A sheet" is filled out for every flight. The pink and yellow gripe sheets (if any) for the previous flight follow this form, as shown in Figure 4.

Fig 2: *Aircraft Inspection and Acceptance Record (A Sheet)*

Fig 3: *Pink/Yellow Gripe Sheet*

Fig 4: *Typical Aircraft Form Sequence*

3. Outstanding and completed maintenance actions

NOTE: As on the T-34, the outstanding and completed maintenance actions are logged on the pink and yellow gripe sheets. These sheets (Figure 3) are part of the VIDS/MAF form (OPNAV Form 4790/60), which is filled out during the maintenance debriefing for that flight. The pink and yellow gripe sheets are identical, being copies of the original form.

The pink gripe sheet identifies outstanding maintenance actions for the aircraft and is offset from other maintenance forms to make outstanding maintenance readily apparent. Safety of flight maintenance items are indicated by a mark in the DOWN box. The aircraft cannot be flown if any outstanding safety of flight maintenance actions exist. Non-safety of flight maintenance actions, indicated by a mark in the UP box, indicate that the aircraft can fly, but with reduced capability.

The yellow (manila colored) gripe sheet identifies a maintenance action that has been completed and will have an entry in the CORRECTIVE ACTION block and signatures in the following blocks: CORRECTED BY, INSPECTED BY, SUPERVISOR, and MAINT CONTROL.

When reviewing the gripe sheets, first verify that there are no outstanding safety of flight maintenance actions, indicated by a check mark in the DOWN box at the bottom of a pink gripe sheet. If no safety of flight maintenance items exist, review the non-safety of flight discrepancies, so you will understand what capabilities (if any) the aircraft lacks. Based on this information, you can determine if the aircraft is

suitable/unsuitable for your mission. For example, if you were to find a HUD discrepancy, the aircraft may not be suitable for an ordnance hop. However, a HUD discrepancy would not prevent a normal cross-country hop. Also check the pink and/or yellow gripe sheets from the last 10 flights for any recurring problems. Depending on the recurring problem, the aircraft may not be suitable for your mission. For example, if the aircraft has a history of avionic problems, it probably would not be a good idea to take it on a long-distance cross-country.

B. *Exterior inspection*

NOTE: Prior to exterior inspection, the cockpit area is checked. This is covered in CO-02.

NOTE: Italicized passages are excerpted from NATOPS.

Fig 5: *Preflight Inspection Path*

LESSON NOTES

For the following section on external inspection, passages headed "VIDEO NOTE" are keyed to corresponding titles on each video frame and your Lesson Guide margin.

WARNING: If the inner gear doors are open, ensure the gear door pins are inserted prior to entering the closing path of the doors. Failure to mechanically safe the doors will result in injury to personnel in the closure path, if the engine is started or hydraulic pressure applied.

T-45C On Ramp

VIDEO NOTE: The preflight begins while you are approaching the aircraft. Look for the obvious, such as FOD, general integrity of the aircraft, chocks in place, and fluid leakage on the ramp.

T-45C On Ramp

VIDEO NOTE: At NAS Meridian the plane captain will remove the landing gear and arresting hook safety pins. The flaps may be down if the aircraft has not been flown recently.

1. *Left forward fuselage*

Left Forward Fuselage

VIDEO NOTE: The major inspection items of the left forward fuselage are the engine intake duct, marker beacon and UHF/VHF No. 2 antennas, angle of attack (AOA) probe, and the left portion of the windshield and canopy.

Left Forward Fuselage

VIDEO NOTE: Check the surface of the left forward fuselage for popped rivets, tears, cracks, dents, or abnormal ripples (indicated by distorted reflections) in the metal. Slight ripples in the metal are normal and occur during manufacture. Use these criteria when performing surface checks during the preflight.

Engine Intake Duct

a. *Engine intake/duct - CLEAR*

Conpressor Blades

VIDEO NOTE: Check the engine intake lip for cracks or other damage, such as dents or corrosion. Use your flashlight to check inside the intake for foreign objects, damage to the duct surface, and to the engine compressor blades.

UHF/VHF and Marker beacon No. 2 antennas:

UHF/VHF And Marker Beacon No. 2 Antennas

b. *Marker beacon antenna - CONDITION*

Marker Beacon Antenna

VIDEO NOTE: Check the marker beacon antenna for loose/missing hardware, cracks, or other damage.

UHF/VHF No. 2 Antenna

AOA Ttansmitter Probe

AOA Probe, Detail

c. *UHF/VHF No. 2 antenna - CONDITION*

VIDEO NOTE: Check the UHF/ VHF No. 2 antenna for loose/ missing hardware, cracks, or other damage.

d. *AOA probe - CONDITION*

e. *Windscreen/canopy - CONDITION*

Windscreen

VIDEO NOTE: Check the left side of the windscreen and canopy for cracks, deep nicks, or scratches.

Canopy

2. *Nose section*

VIDEO NOTE: The major nose section inspection items inspected from the left side are the left avionics access door, ram air inlet, IFF and TACAN antennas, and Pitot static tube.

Nose Section, Left

VIDEO NOTE: Check that the emergency nose landing gear door safety pin is removed.

Emergency Gear Door Safety Pin

Left Avionics Door

Left Avionics Door Close-up

a. *Left avionics access door - SECURED*

VIDEO NOTE: Check that the left avionics door is flush with the adjacent aircraft skin (not warped). Weather seal or other foreign material should not protrude between the door and aircraft skin.

Ram Air Inlet

Ram Air Inlet Detail

b. *Ram air inlet - CONDITION*

VIDEO NOTE: Check the ram air inlet for damage and obstructions.

IFF Antenna

c. *IFF antenna - CONDITION*

VIDEO NOTE: Check the IFF antenna for cracks or other damage.

TACAN Antenna

d. *TACAN antenna - CONDITION*

VIDEO NOTE: Check the TACAN antenna for cracks or other damage.

Pitot Static Tube

e. *Pitot static tube - CONDITION*

WARNING: Ensure the Pitot switch is OFF prior to touching the Pitot tube. The power to the Pitot heater is not routed through the aircraft weight-on-wheels switch. Touching the Pitot tube may cause burns.

VIDEO NOTE: Since the Pitot tube gets hot, some heat discoloration is normal. Check the Pitot and static ports for obstructions and damage, such as nicks or other deformations.

Check the entire length of the boom for looseness, cracks, or other damage.

VIDEO NOTE: The major nose section items inspected from the right side of the nose section are the right avionics access door and the total temperature probe.

Right Avionics Door

f. *Right avionics access door - SECURED*

VIDEO NOTE: The inspection of the right avionics door is the same as for the left avionics access door.

Total Temperature Probe

g. *Total temperature probe - CONDITION*

Since the total temperature probe does get hot, some discoloration is normal. Check it for damage such as nicks or dents and loose/ missing attaching hardware.

Nose Landing Gear

Nose Wheelwell

3. *Nose landing gear and wheelwell*

VIDEO NOTE: The first major inspection items in this area are the nose landing gear, the nose wheelwell, doors, and linkages.

VIDEO NOTE: Looking inside the nose wheelwell, check all hydraulic lines, connectors, and seals for evidence of leakage (use your flashlight, if necessary). Leakage could be indicated by fresh hydraulic fluid on equipment inside the wheelwell or on the ground. Since oil attracts dirt and dust, another indication could be an accumulation of dirt in a place that

is normally clean. Use these criteria when checking for leaks throughout the preflight. Check for loose/missing hardware and equipment and for cracks in metal or other damage. The area should be free of all foreign objects such as tools, rags, etc.

Nose Landing Gear Door Hinges

Nose Gear Linkages

a. *Gear doors and linkages - CONDITION*

VIDEO NOTE: Check all door hinges and operating linkages for loose/missing hardware, cracks, or other damage.

b. *Tires, wheels, strut - INFLATION, TREAD WEAR, CONDITION*

Nose Gear Strut (Front View)

VIDEO NOTE: Check the nose strut for cracks in metal, loose/ missing hardware or equipment, and leaking hydraulic lines and connectors. Check the strut oleo for evidence of leakage. Leaks can be indicated by fresh hydraulic fluid on equipment or the ground, or an accumulation of dirt in a place that is normally relatively clean.

NLG Tires

VIDEO NOTE: Check the tires for tread wear, flat spots, and deep cuts exposing the cords. The tire should be replaced if you note any flat spots or exposed cords.

VIDEO NOTE: Check the tires for correct inflation. Since you will not have a tire gauge, look carefully at each tire for evidence of underinflation, such as a flattened profile on the bottom. Since both tires are on the same axle, one tire

may be underinflated and supported by the other. Nosewheel tire pressure varies between 145 psi for field operation and 325 psi for carrier operation, so there should be very little, if any, bulge in the tire profile.

VIDEO NOTE: Check inboard and outboard sides of the wheels for loose/missing hardware such as lug nuts and the main nuts securing the wheels to the axles.

Nose Gear Oleo

c. *Strut pressure - CHECK FOR APPROXIMATELY 3.25 INCHES OF EXPOSED CHROME*

VIDEO NOTE: Check that the exposed chrome is about four fingers wide.

d. *Launch bar - CONDITION*

Launch Bar

VIDEO NOTE: The launch bar system consists of the launch bar and actuator mechanism. Remember that during launch, the launch bar transfers the pressure (torque) generated by the entire mass of the aircraft multiplied by the force of the accelerating catapult to the frame of the aircraft, making the launch bar a critical inspection item.

Launch Bar Mechanism

VIDEO NOTE: Inspect the launch bar and pivot mechanism for cracks, distortion, or other damage. Check the “T” for cracks and damage.

Launch Bar "T"

Launch Bar Linkages

VIDEO NOTE: Check the launch bar actuator mechanism and linkage for damage and loose/ missing hardware. Check actuator hydraulic lines and connectors for evidence of leakage.

Nose Wheel Steering Assembly

e. *Nose wheel steering assembly - CONDITION*

NWS Motor And Gearbox

NWS Electronic Control Box

VIDEO NOTE: The major inspection items of the nose wheel steering assembly are the motor and gearbox, electronic control box, and steering collar.

VIDEO NOTE: Inspect the motor and gearbox for damage and loose/missing hardware. Check the motor hydraulic lines and connectors for evidence of leakage. The electronic control box is a sealed unit—check for damage to the case and wire harness. Check the steering collar and linkage to the gearbox for damage and loose/missing hardware.

Taxi/Landing Light

f. *Taxi/landing light - CONDITION*

VIDEO NOTE: Check the taxi/ landing light assembly, including the lamp and wiring harness, for damage and loose/missing hardware.

Approach Light

Taxi/Landing Approach Light Wiring

g. *Approach light - CONDITION*

VIDEO NOTE: Check the approach light assembly and the wiring harness for damage and loose/missing hardware. Check

the lenses closely for damage and evidence of water entry (fogged lens).

Holdback & Drag Brace

h. *Holdback - CONDITION*

VIDEO NOTE: The remaining inspection items of the nose wheelwell and landing gear area are the holdback and drag brace.

Holdback

VIDEO NOTE: The holdback carries the force of the engine at full thrust while waiting for launch, making it a critical inspection item. Check the holdback for cracks or other damage, especially where it attaches to the strut.

i. *Drag brace - SAFETY PIN PULLED AND STOWED*

Drag Brace

VIDEO NOTE: Like the launch bar during launch, the drag brace transfers the torque generated by acceleration during takeoff and catapult launch and during deceleration on landing to the frame of the aircraft. This makes the drag brace a critical inspection item. Inspect the drag brace, including the forward and aft attachment points, for cracks or other damage. Check the drag brace fixed door and attachment points for damage and loose/ missing hardware. Check the hydraulic lines and connectors for evidence of leakage.

4. *Right forward fuselage*

Right Forward Fuselage

VIDEO NOTE: Major inspection items of the right forward fuselage include, the right side of the windscreen, avionics bay and access door, lower anti-collision light, and engine intake duct.

a. *Windscreen/canopy - CONDITION*

Right Canopy

VIDEO NOTE: Check the right side of the windscreen/canopy for cracks, deep nicks, and scratches.

b. *Avionics bay and access doors - SECURED*

Avionics Bay

VIDEO NOTE: Check that the avionics bay and electrical access doors are flush with the adjacent aircraft skin and attaching screws are secure.

Lower Anti-Collision Light

c. *Lower anti-collision beacon - CONDITION*

VIDEO NOTE: Inspect the lower anti-collision beacon for internal and external damage, including evidence of water entry.

Right Intake Lip And Duct

d. *Engine intake/duct - CLEAR*

Right Compressor Blades

VIDEO NOTE: Check the engine intake lip for cracks or other damage, such as dents or corrosion. Use your flashlight to check inside the intake for foreign objects, damage to the duct surface, and to the engine compressor blades.

Right MLG

5. *Right main landing gear and wheelwell*

VIDEO NOTE: The major inspection items of the right main wheelwell are the gear doors and linkages, the HYD 1 flight control accumulator and wheel brakes/emergency flap system accumulator pressure gauges, and the landing gear downlock and the retract actuators.

Right Main Wheelwell

VIDEO NOTE: While inspecting the right main wheelwell and landing gear, check for evidence of leakage on hydraulic lines and connectors and on the ground as previously stated. Also check for loose/missing hardware, cracks, or other damage to equipment. The area should be free of all foreign objects such as tools, rags, etc.

Right MLG Inner Door

Right MLG Inner Door Actuator

HYD 1 FC Accumulator Gauge

a. *Gear doors and linkages - CONDITION*

VIDEO NOTE: Inspect the gear doors and operating linkages for loose/missing hardware, cracks, or other damage.

b. *HYD 1 flight control accumulator pressure gauge - CHECK (1,100 ± 50 psi)*

VIDEO NOTE: Verify that the HYD 1 flight control accumulator pressure gauge indicates pressure as labeled on the gauge placard (1,100 ± 50 psi). If pressure is not within indicated limits, the system requires service before flight.

Wheel Brake/Emergency Flap Accumulator Pressure Gauge

c. *Wheel brakes/emergency flap system accumulator pressure gauge - CHECK (1,250 psi or greater)*

Verify that the wheel brakes/ emergency flaps accumulator pressure gauge indicates pressure as labeled on the gauge placard (1,250 psi or greater). If pressure is not within indicated limits, the system requires service before flight.

Downlock & Retract Actuators

d. *Landing gear downlock and retract actuators - CONDITION*

Downlock Actuator, Detail

Retract Actuator, Detail

VIDEO NOTE: The downlock actuator is located on the landing gear side brace and the retract actuator is located on the strut.

e. *Gear pin - PULLED AND STOWED*

VIDEO NOTE: Check for cracks or other damage to the downlock and retract actuators, especially at the attachment points. Check hydraulic lines, connectors, and actuator rod seals for evidence of leakage.

f. *Wheel strut - CHECK FOR 7/8 to 1-7/8 INCHES OF EXPOSED CHROME*

Right MLG

Right MLG Oleo

VIDEO NOTE: The remaining major inspection items in this area are located on the right main landing gear. These items are the oleo, tire and wheel, brake wear indicators, and tie down rings and springs. While looking at the checklist items in this area, check

hydraulic lines and connectors for evidence of leakage. Check for loose/missing hardware, cracks, or other damage to the strut.

VIDEO NOTE: Wheel strut - Check for 7/8 to 1-7/8 inches of exposed chrome.

g. *Tire - TREAD WEAR, INFLATION*

Right MLG Tire

VIDEO NOTE: Check tread for flat spots, deep cuts, and exposed cords. If any of these exist, the tire should be replaced. Check the tire for adequate inflation. Because you do not have a tire gauge, you will have to compare the right and left tires for similar profile. The correct tire pressure depends on whether landings will be on an aircraft carrier or an airfield. Check the inboard and outboard sides of the wheel for damage and loose/missing hardware, such as lug nuts and the nut securing the wheel to the axle.

h. *Brake wear indicators - CHECK INDICATORS PROTRUDING BEYOND BOTTOM OF RECESSES IN BRAKE HOUSING*

VIDEO NOTE: The upper and lower brake wear indicators must be checked with either the pedal brakes or the parking brake applied. The upper and lower brake wear indicators on each main wheel must protrude through the brake housing.

Lower Brake Wear Indicator Close Up

VIDEO NOTE: If any indicator is flush or recessed, the brakes must be replaced.

MLG Tie Down Ring, Forward Side

VIDEO NOTE: Two sets of tie down rings and springs are located on the right main landing gear—one on the forward side of the strut above the trailing arm hinge and the other on the inboard side of the trailing arm, adjacent to the wheel.

Tie Down Ring, Trailing Arm

i. *Tie down rings and springs - CONDITION*

VIDEO NOTE: Check the forward and aft tie down rings and springs for loose/missing hardware, cracks, or other damage.

Right Wing

6. *Right wing*

a. *Pylon and external stores - PREFLIGHT*

Check that the pylon is secure; preflight of the stores are covered in weapons.

Right Wing Top

VIDEO NOTE: The major inspection items on the top and leading edge of the right wing are the slat, the stall strip, and the vortex generators.

Right Wing Slat

b. *Slat - CONDITION*

VIDEO NOTE: Check the slat for security, popped rivets, cracks, or other damage.

Right Stall Strip

c. *Stall strip - CONDITION*

VIDEO NOTE: Check the stall strip for cracks or other damage.

Vortex Generators

d. *Vortex generators - CONDITION*

VIDEO NOTE: Check for missing or damaged vortex generators.

Right Wingtip

VIDEO NOTE: The inspection items on the right wingtip are the navigation light, the glideslope antenna, and the formation light.

Right Navigation Light

e. *Navigation light - CONDITION*

VIDEO NOTE: Check for damage to the outer lens, including water entry. Check for loose/missing attaching hardware.

f. *Glideslope antenna - CONDITION*

Right Formation Light & Glideslope Antenna

g. *Formation light - CONDITION*

VIDEO NOTE: Check the glideslope antenna and the formation light for loose/missing attaching hardware, cracks, or other damage. Check the formation light for evidence of water entry.

Right Wing Trailing Edge

VIDEO NOTE: The major inspection items on the trailing edge of the wing are the aileron and flap.

Right Aileron

Right Flap

h. *Aileron and flap - CONDITION*

VIDEO NOTE: Check the aileron and flap for popped rivets, cracks, or other damage. Check for damage and obstructions in the hinge and actuator areas. Check the area between the wing and flap/aileron for foreign objects.

Top Right Fuselage

NOTE: Check the following items on the top fuselage; the environmental control system (ECS) intake and exhaust ports, the anti-collision beacon/strobe light, the UHF/VHF No. 1 antenna.

VIDEO NOTE: From the ground, verify that covers have been removed from the GTS exhaust and right ECS intake and exhaust ports. Check the UHF/VHF No. 1 antenna, anti-collision beacon, and strobe lights for obvious damage.

Right Aft Fuselage

7. *Aft fuselage (right side)*

VIDEO NOTE: The major inspection items of the right aft fuselage are the steam ingestion bleed air dump vent, No. 1 hydraulic reservoir, the GTS oil reservoir indicator, the HYD 1 filter indicators, the engine access door, and RAT doors.

Steam Ingestion Bleed Air Vent

a. Steam Ingestion Bleed Air Dump Vent - CONDITION/ UNOBSTRUCTED

VIDEO NOTE: Check that the steam ingestion bleed air vent is clear and attaching hardware is secure.

GTS Oil Reservoir Level

b. *GTS oil reservoir indicator - CHECK*

VIDEO NOTE: Verify that the oil level in the GTS oil reservoir indicator sight glass is between the MIN and MAX lines. If the oil level cannot be seen, the GTS oil reservoir requires service before attempting engine start.

c. *Hydraulic 1 filter indicators (2) - RECESSED*

HYD 1 Filter Indicators

HYD 1 Filter Indicators

VIDEO NOTE: Verify that the hydraulic filter indicators are flush or slightly recessed.

VIDEO NOTE: If either indicator is protruding, that filter must be serviced/replaced before flight.

d. HYD 1 reservoir indicator - CHECK

HYD 1 Reservoir Indicator

VIDEO NOTE: Although not listed in NATOPS, verify that the pointer is within the acceptable range indicated by the highlighted band (276 +/- 6 cu inch). If the pointer is above or below the band, the No. 1 hydraulic system requires service before flight.

e. *Engine access doors - SECURED*

Engine Access Doors

VIDEO NOTE: Check that the engine access doors are flush with the adjacent aircraft skin and attaching screws are secure.

f. *RAT doors - INSPECT FOR DISCOLORATION AND WARPAGE*

RAT Doors

VIDEO NOTE: Inspect the RAT doors for paint discoloration and warped doors.

8. *Tail section (right side)*

Right Tail Section

VIDEO NOTE: Major inspection items on the right side of the tail section are the speed brake, stabilator vane, stabilator, and vertical stabilizer including rudder and trim tab.

Right Speed Brake

a. *Speed brake - CONDITION*

VIDEO NOTE: Check the speed brake for cracks or other damage and make sure it fits flush with the aircraft skin (not warped).

Right Stabilator Vane

b. *Stabilator vane - CONDITION*

VIDEO NOTE: Check the stabilator vane for popped rivets, cracks, or other damage.

Stabilator Fuselage Junction

c. *Stabilator - CONDITION*

VIDEO NOTE: Check the area between the stabilator and tail section for obstructions and damage, such as an arc — which indicates that the stabilator has been rubbing against the fuselage.

GTS Drain Mast

d. GTS fuel drain - CONDITION

VIDEO NOTE: Check GTS drain mast for security.

Vertical Stabilizer
Rudder Trim Tab

e. *Vertical stabilizer, rudder, rudder tab, buzz strips - CONDITION*

VIDEO NOTE: Check the rudder and trim tab for damage and obstructions in the hinge area, and for loose buzz strips.

Tail Section

f. *Tail pipe/turbine blades - CONDITION (Check tailpipe sleeve travel and security - pull to full aft travel)*

VIDEO NOTE: The remaining inspection items of the right side of the tail section are the tailpipe, navigation light, IFF antenna, TACAN antenna, and fuel vent.

Tailpipe Check #1

VIDEO NOTE: Check the tailpipe lip and inside the tailpipe for cracks or other damage, such as warped metal from excess heat. Check for foreign objects and obvious damage to the turbine blades. Push the tailpipe in then pull aft; the tailpipe should move about 1/8 in.

Tailpipe Check #2

Navigation Light and IFF Antenna

g. *Navigation light - CONDITION*

h. *IFF antenna - CONDITION*

VIDEO NOTE: Check for loose/ missing attaching hardware and damage to the navigation light and IFF antenna. Check for evidence of water entry into the navigation light.

Fuel Vent

I. *Fuel vent - CONDITION/ UNOBSTRUCTED*

VIDEO NOTE: Check the fuel vent for damage or obstructions.

Left Tail Section

9. *Tail section (left side)*

VIDEO NOTE: The major tail section items inspected from the left side that are the same as the right side are the stabilator, stabilator vane, speed brake, and vertical stabilizer. In addition, the arresting hook and hook bumpers are inspected on the left side.

a. *Vertical stabilizer, rudder, buzz strips - CONDITION*

VIDEO NOTE: Check the rudder and trim tab for damage and obstructions in the hinge area, and for loose buzz strips.

b. *Stabilator - CONDITION*

Perform a surface check of the top and the bottom sides of the stabilator, the same as the right stabilator.

VIDEO NOTE: Check the area between the stabilator and tail section for obstructions and damage, such as an arc — which indicates that the stabilator has been rubbing against the fuselage.

c. *Stabilator vane - CONDITION*

VIDEO NOTE: Check the stabilator vane for popped rivets, cracks, or other damage.

d. *Speed brake - CONDITION*

VIDEO NOTE: Check the speed brake for cracks or other damage and make sure it fits flush with the aircraft skin (not warped).

Arresting Hook Bumpers

e. *Arresting hook bumpers (2) - CONDITION*

VIDEO NOTE: Check that the arresting hook bumpers are secure and there is no damage to the fuselage skin.

Arresting Hook
Arresting Hook Point

Arresting Hook
Uplatch

f. *Arresting hook - RETRACTED, SAFETY PIN REMOVED AND STOWED*

VIDEO NOTE: Check for cracks or other damage, especially to the hook point and uplatch mechanism. Check for loose/ missing hardware. Verify that the safety pin is removed.

g. *Hook actuator/damper pressure - CHECK (approximately 950 psi)*

Arresting Hook/Actuator/Damper

Arresting Hook Actuator/Damper Pressure Gauge

VIDEO NOTE: The hook actuator/ damper pressure gauge should indicate approximately 950 psi. If the pressure is too low, the hook may bounce over the cable. If pressure is too high, damage to equipment might occur. (Panel over pressure gauge removed).

10. *Aft fuselage (underside)*

Bottom Aft Fuselage

VIDEO NOTE: The major inspection items on the underside of the aft fuselage are the radar altimeter antennas and the engine access doors.

a. *Radar altimeter antennas - CONDITION*

Radar Altimeter Antenna, Fwd

Radar Altimeter Antenna, Aft

VIDEO NOTE: Check the forward and aft radar altimeter antennas for loose/missing attaching hardware, cracks, or other damage.

b. *Engine access doors - SECURED*

Engine Access Door

Engine Fuel Drain

VIDEO NOTE: The inspection of the engine access doors is the same as for the engine access door (right side).

c. *Engine and GTS fuel drains - CONDITION/UNOBSTRUCTED*

Aft Fuselage Left Side

11. *Aft fuselage (left side)*

VIDEO NOTE: The major inspection items on the left aft fuselage are the No. 2 hydraulic reservoir and filter indicators.

HYD 2 Filter Indicators

a. *HYD 2 filter indicators (2) - RECESSED*

VIDEO NOTE: Verify that the hydraulic filter indicators are flush or slightly recessed.

HYD 2 Reservoir Indicator

b. HYD 2 reservoir indicator - CHECK

VIDEO NOTE: Verify that the pointer is within the acceptable range indicated by the highlighted band (256 +/- 6 cu inch). If the pointer is above or below the band, the No. 2 hydraulic system requires service before flight.

Left Wing

12. *Left wing*

VIDEO NOTE: The major inspection items on the wing are the flap, aileron, and slat.

Flap and Aileron

a. *Flap and aileron - CONDITION*

VIDEO NOTE: Check the aileron and flap for popped rivets, cracks, or other damage. Check the area between the wing and flap/aileron for foreign objects. Check for damage and obstructions in the hinge and actuator areas.

Left Wingtip

VIDEO NOTE: The inspection items on the left wingtip are the formation light, the VOR/LOC antenna, and the navigation light.

b. *Formation light - CONDITION*

VOR/LOC Antenna and Formation Light

c. *VOR/LOC antenna - CONDITION*

VIDEO NOTE: Check for loose/ missing attaching hardware, cracks, or other damage to the formation light and VOR/LOC antenna.

Left Navigation Light

d. *Navigation light - CONDITION*

VIDEO NOTE: Check for damage to the outer lens and the interior, including water entry. Check for loose/missing attaching hardware.

Top Left Wing

VIDEO NOTE: The major inspection items on the top and the leading edge of the left wing are the vortex generators, slat, and stall strip.

e. *Vortex generators - CONDITION*

f. *Stall strip - CONDITION*

VIDEO NOTE: The inspection for the left wing vortex generators, slat, and stall strip is the same as for the right wing.

g. *Slats - CONDITION*

VIDEO NOTE: Check the slat for security, popped rivets, cracks, or other damage.

h. *Pylon and external stores - PREFLIGHT*

Check that the pylon is secure; preflight of the stores is covered in weapons.

Top Left Fuselage

13. Top fuselage (left side)

VIDEO NOTE: Check the following items on the top fuselage: the left ECS intake and exhaust port covers, the anti-collision beacon/strobe, and the UHF/VHF No. 1 antenna.

VIDEO NOTE: Perform a surface check of the left side of the top fuselage.

a. Left ECS intake and exhaust port covers - REMOVED

VIDEO NOTE: From the ground, verify that covers have been removed from the left ECS intake and exhaust ports.

Left MLG

14. *Left main landing gear and wheelwell*

VIDEO NOTE: The major inspection items of the left main wheelwell are the gear doors and linkages, the HYD 2 flight control accumulator pressure gauge, the landing gear downlock and retract actuators. While inspecting the left main wheelwell, be alert for the same general discrepancies as when you inspected the right main wheelwell.

Left MLG

VIDEO NOTE: The major inspection items in this area are located on the left main landing gear. These items are the oleo, tire and wheel, brake wear indicators, and tie down rings and springs.

a. *Tie down rings and springs - CONDITION*

b. *Brake wear indicator - CHECK INDICATORS PROTRUDING BEYOND BOTTOM OF RECESSES IN BRAKE HOUSING*

c. *Tire - TREAD WEAR, INFLATION*

d. *Wheel strut - CHECK FOR 7/8 to 1-7/8 INCHES OF EXPOSED CHROME*

e. *Gear pin - PULLED AND STOWED*

f. *Landing gear downlock and retract actuators - CONDITION*

HYD 2 Flight Control Accumulator

g. *HYD 2 flight control accumulator pressure gauge - CHECK (1,100 ± 50 psi)*

h. *Gear doors and linkages - CONDITION*

SUMMARY

This lesson has reacquainted you with Aircraft Discrepancy Book and introduced you to the exterior preflight inspection for the T-45C.

CONCLUSION

You must understand how to perform a thorough aircraft preflight inspection because it is the first essential step to carrying out your mission successfully.

FIGURES

OPNAV 4790/12C

PREFLIGHT/DAILY/TURNAROUND/POSTFLIGHT MAINTENANCE RECORD

1. ☐ PREFLIGHT ☐ DAILY ☐ TURNAROUND ☐ POSTFLIGHT

2. DATE AND TIME STARTED _____ COMPLETED _____	3. T/M/S	4. BUNO	5. SIDE NO.	6. ACTIVITY

7. CARD NUMBER/ RTG/MOS	8. TOOL CONTAINER NUMBER	9. DISCREPANCY/JCN *	10. CORRECTED		11. SIGNATURE AND RATE/MOS **
			YES	NO	

* JCN NOT REQUIRED FOR CORRECTED SERVICING ACTIONS.
** SIGNATURES CERTIFY THAT MRCs HAVE BEEN COMPLIED WITH, VIDS/MAFs HAVE BEEN INITIATED FOR DISCREPANCIES, AND ALL TOOLS ARE ACCOUNTED FOR.

12. MAINTENANCE CONTROL REPRESENTATIVE
(Signature and rate/rank)

OPNAV 4790/12C REV 2/95 PREVIOUS EDITIONS MAY BE USED UNTIL SUPPLY IS EXHAUSTED S/N 0107-LF-047-9031

Figure 1: PREFLIGHT/DAILY/TURNAROUND/POSTFLIGHT MAINTENANCE RECORD

AIRCRAFT INSPECTION AND ACCEPTANCE RECORD OPNAVINST 4790.2D

1. AC BU/SER NO.	2. T/M/S	3. RPT CUST.	4. OXY	5. FUEL GRADE	5. FUEL QTY	6. OIL GRADE	6. OIL 1	6. OIL 2	6. OIL 3	6. OIL 4	7. DATE

8. ORDNANCE / SPECIAL EQUIPMENT / LIMITATIONS / REMARKS:	9. I have personally inspected this aircraft IAW the applicable MRCs/ checklists. Any discrepancies noted have been entered on OPNAV 4790/38.
	SIGNATURE OF PLANE CAPTAIN RANK/RATE
	10. Certification of safe for flight condition by the MO, MMCO, or MCO. Other persons may sign this form if authorized.
	SIGNATURE RANK/RATE
	11. I have inspected the last _____discrepancy reports, insured proper filing of weight and balance data and accept this aircraft for flight.
	SIGNATURE OF PILOT IN COMMAND RANK

OPNAV 4790/14 (2-88) REPLACES OPNAV 3760/2D WHICH MAY BE USED UNTIL SUPPLIES ARE EXHAUSTED S/N 0107-LF-047-9006

★ U.S. GPO 1987-531-178

Figure 2: AIRCRAFT INSPECTION AND ACCEPTANCE RECORD (A SHEET)

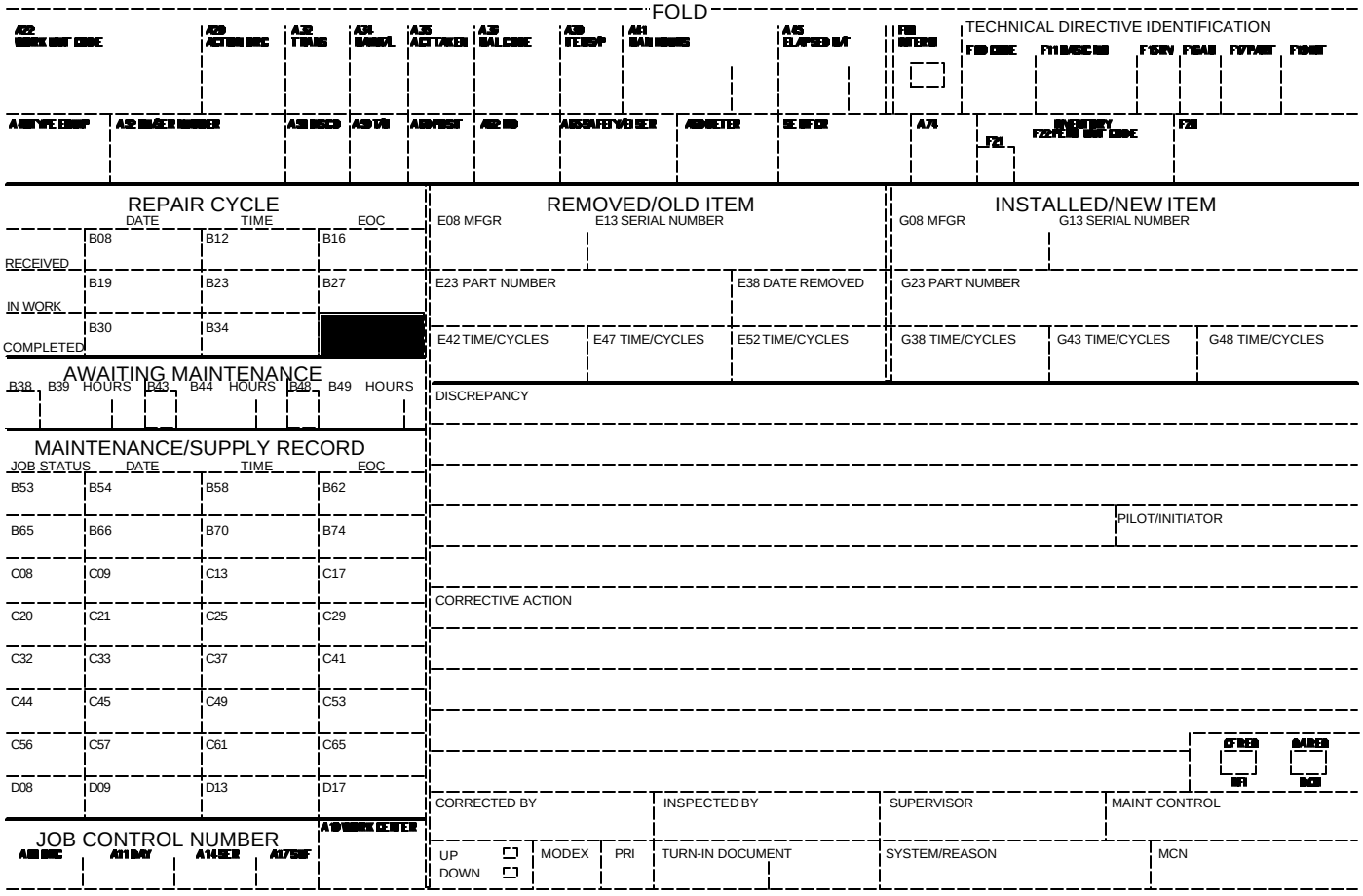


Figure 3: PINK/YELLOW GRIPE SHEET

A SHEET

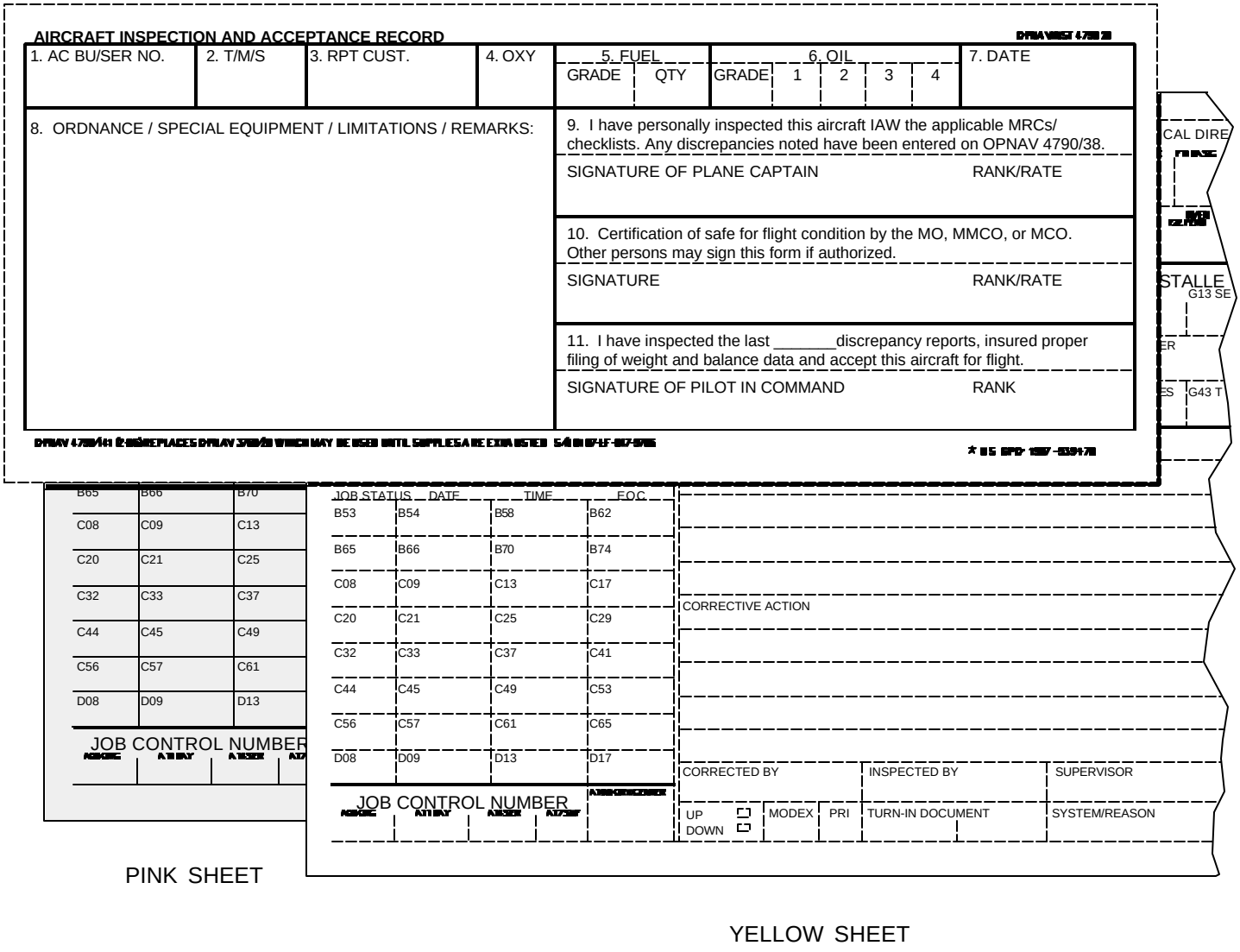
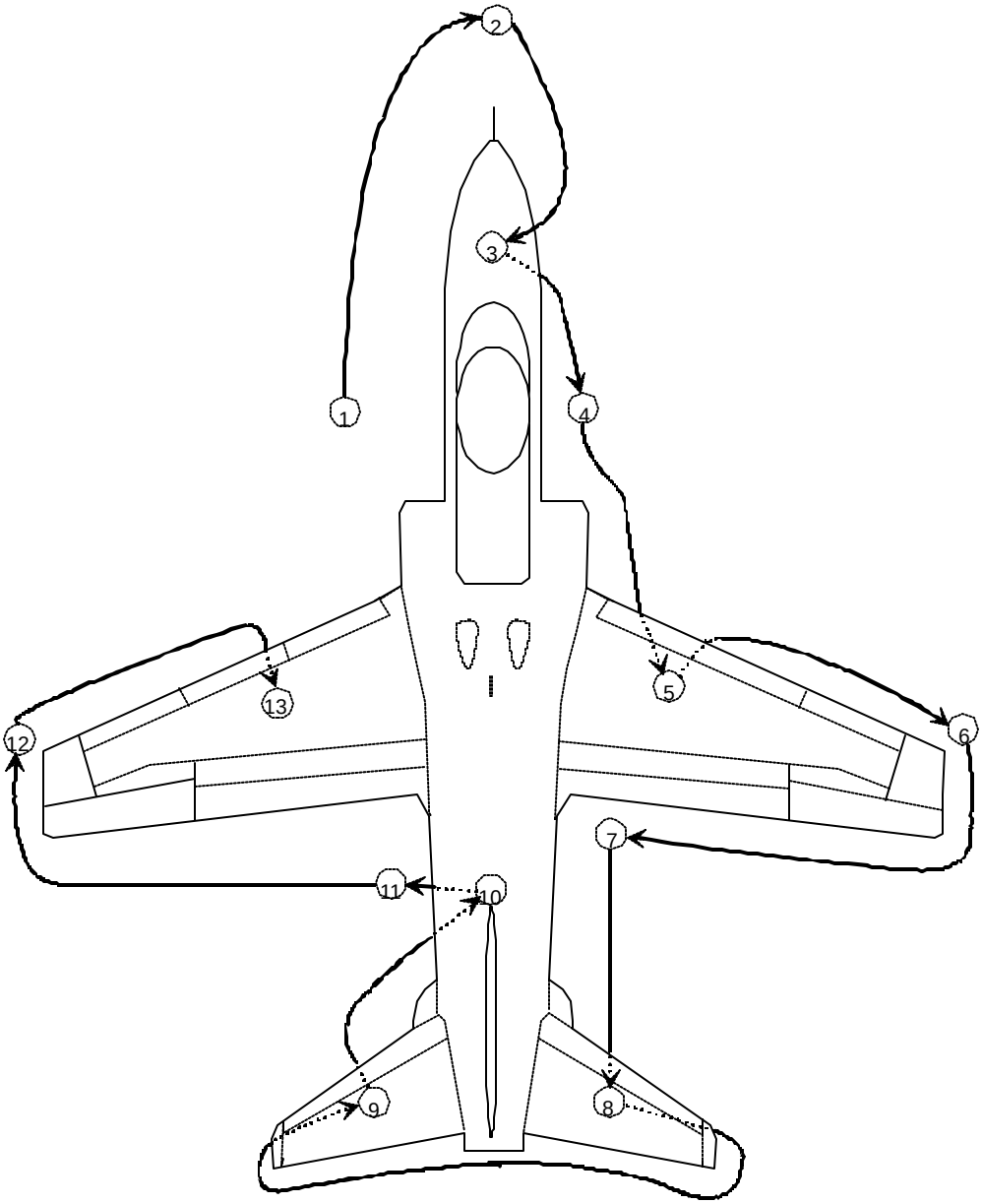


Figure 4: TYPICAL AIRCRAFT FORM SEQUENCE



1. Left Forward Fuselage
2. Nose Section
3. Nose Landing Gear and Wheelwell
4. Right Forward Fuselage
5. Right Main Landing Gear and Wheelwell
6. Right Wing
7. Aft Fuselage (right side)
8. Tail Section (right side)
9. Tail Section (left side)
10. Aft Fuselage (underside)
11. Aft Fuselage (left side)
12. Left Wing
13. Left Main Landing Gear and Wheelwell

Figure 5: PREFLIGHT INSPECTION PATH

LESSON GUIDE

COURSE/STAGE: TS, ADV, & IUT / Cockpit Orientation

LESSON TITLE: Engine Start and Poststart

LESSON IDENTIFIER: T-45C TS, ADV, & IUT CO-02

LEARNING ENVIRONMENT: CAI

ALLOTTED LESSON TIME: 1.0 hr

STUDY RESOURCES:

* T-45C NATOPS Flight Manual, A1-T45AC-NFM-000
* T45C NATOPS Pilot's Pocket Checklist, A1-T45AC-NFM-500

LESSON PREPARATION:

Read:

* Chapter 2, “System Descriptions", 2.14 "Boarding System", Chapter 7, "Shore Based Procedures", 7.3 "Entering Cockpit", T-45C NATOPS Flight Manual, A1-T45AC-NFM-000
* Prestart Checks, Starting Engine, and Poststart, T-45C NATOPS Pilot's Pocket Checklist, A1-T45AC-NFM-500

Review:

* Lesson Guide, ENG-26, Engine Start Procedures

(10-99) ORIGINAL

REINFORCEMENT: N/A

EXAMINATION:

The objectives in this lesson will be evaluated on simulator and aircraft events.

LESSON OBJECTIVES

Class Preparation

1.3.5.1.1
Recall inspection criteria for canopy and ejection seat

1.10.4.3.1
Recall procedures for normal egress

1.3.5.3.1
Recall procedures for strapping in

Lesson Presentation

1.3.6
Perform prestart checklist

1.4.1.1.2
Recall function of controls for engine start

1.4.1.1.2.1
Locate controls for engine start

1.4.1.1.1
Recall engine start procedures

1.4.3
Perform poststart checklist

1.5.3.1.2.3
Identify unacceptable conditions for engine start checks

MOTIVATION

After several flights, the cockpit interior checks and engine start procedures may become mundane, but, it is imperative that these checks be accomplished expeditiously and correctly so that ground time is minimized. In addition, you must closely monitor engine start to insure that you do not allow the rare occurrence of an abnormal start to progress to the point that the engine is damaged.

OVERVIEW

In this lesson, you will gain practical knowledge of engine starting procedures and abnormal starting indications that will build on your basic understanding of engine operation that you gained in Engineering.

You will identify the location and function of engine starting controls and indicators, and go through the prestart checks, normal engine start and poststart procedures. You will then have an opportunity to identify unacceptable engine starting indications.

REFRESHER

Recall:

* Location and function or cockpit engine indicators
* Location and meaning of warning, caution, and advisory lights

CLASS PREPARATION

A. Canopy and ejection seat inspection 1.3.5.1.1: review Chapter 7, “Shore Based Procedures,” paragraph 7.3.1 in the T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

B. Normal egress 1.10.4.3.1 review Chapter 2, “System Description,” 2.14 “Boarding System” in the T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

C. Strapping in 1.3.5.3.1 review Chapter 7, “ Shore Based Procedures,” paragraph 7.3.2 in the T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

PRESENTATION

I. Prestart checks **1.3.6**

NOTE: The NATOPS prestart checklist is not duplicated in this lesson guide. Use the Pilot's Pocket Check List for prestart checks. Additional information about the Prestart Checks is contained in the NATOPS manual.

A. NATOPS step 2. Seat - ADJUST: The three position seat height switch is spring-loaded to the center position. Holding the switch forward lowers the seat and holding the switch aft raises the seat

B. NATOPS step 3. ICS - CHECK: Depress the microphone switch to check the ICS, MIC switch on the communications control panel is in COLD. Moving the microphone switch up or down will transmit on the comm 1 or comm 2 radio respectively

C. NATOPS step 6. Warning/caution/advisory lights panel - ENSURE THE FOLLOWING ON:

SKID Advisory ON: If the SKID advisory is not on, check that the ANTI-SKID switch in both cockpits is ON. If a Warning/caution/advisory light is not illuminated it can be checked by placing the LIGHT TEST/TONE TEST switch in LIGHT TEST

AC INV - on aircraft 165457 and up and on aircraft 165456 and below with AFC 199 incorporated the AC INV caution light will not be illuminated

D. NATOPS step 9. MASTER test switch - LIGHT TEST: Selecting LIGHT TEST illuminates all the warning, caution, advisory lights and tests the fire warning system

E. NATOPS step 10. Pressing the switch to TONE TEST generates the four audio tones in the following sequence:
warning,
caution,
wheels up, and
weapons release

F. NATOPS step 11. HYD 1 and HYD 2 pressure indicators - ZERO: The HYD 1 and 2 pressure gauges in the cockpit show system pressure, not accumulator pressure like the HYD 1 and 2 flight control accumulator pressure gauges checked during the exterior preflight

G. NATOPS step 12. BRAKE pressure indicator - 1,250 PSI MINIMUM: The BRAKE pressure indicator should show a pressure close to the pressure on the wheel brake/emergency flap accumulator pressure gauge in the right main landing gear wheelwell that you checked on preflight

H. NATOPS step 13. FLAP position lights - MATCH FLAP POSITION: Between flights the flaps may bleed down partially or to full down. On start as HYD 1 pressure comes up the flaps will retract

I. NATOPS step 14. Landing gear position indicator lights - ON (GREEN): The DOOR light is on because the plane captain opens the forward nose and outer main landing gear doors during the turn around inspection. On start, as HYD 1 pressure comes up, the doors with close and the DOOR light will go out

J. NATOPS step 15. COMM 1/COMM 2 transfer switches - AS REQUIRED: Press the button to select between FWD or AFT. The illuminated legend indicates the cockpit exercising control of the COMM 1 or COMM 2 radio

II. Starting engine **1.4.1.1.2.1, 1.4.1.1.2, 1.4.1.1.1**

NOTE: Use the Pilot's Pocket Check List for starting engine procedures and F405-RR-401 Operating Limitations.

A. Before starting the engine make certain that the area forward and aft of the aircraft is clear of personnel and FOD hazards. Make certain fire fighting equipment is available and manned. Advise aft cockpit before engine start

B. Keep the engine limitations in mind and observe the sequence of events in the normal engine start. Actual start temperatures observed on the ramp will vary slightly from those presented here due to differences in the outside air temperature, but they should be close to those in this demonstration

III. Poststart Checks **1.4.3**

NOTE: The NATOPS poststart checklist is not duplicated in this lesson guide. Use the Pilot's Pocket Check List for prestart checks. Additional information about the Poststart Checks is contained in the NATOPS manual.

A. NATOPS step 7. HUD - SET BRIGHTNESS: When the AUTO/DAY switch is in AUTO the brightness is automatically controlled according to the ambient light levels. In DAY, the brightness is manually controlled with the brightness control

B. NATOPS step 8. MFD Brightness and contrast - SET: After the brightness and contrast are set, all subsequent display adjustments due to changing light conditions should be accomplished using the CONT control

C. NATOPS step 9. Augmentation progress - CHECK:

1. The initial selection of DATA formats will default to the waypoint data format, subsequent selections of DATA will return to the last selected sub-level data format

2. System alignment begins when the batteries are turned on and alignment is normally completed within four minutes. So the system should be aligned by the time you call up the aircraft display during the poststart checks

3. The legends on aircraft data page: ALGN is the elapsed alignment time. QUAL in the alignment quality in km per hour [the minimum QUAL number is 00.59] GPS SAT is the number of satellites tracked by the system

D. NATOPS step 12. Stabilator trim - CHECK BOTH DIRECTIONS: The stabilator trim indicator will only depict trim position with no forces on the stick. While checking or setting the trim for takeoff or catapult launch, it is important that both pilots not exert longitudinal forces on the stick

E. NATOPS step 14. Standby attitude indicator - PULL TO ERECT: Power should be applied for at least one minute before caging the standby attitude indicator (AI) Pulling the caging knob, cages the indicator. Rotating the knob adjusts the pitch of the miniature aircraft. Pulling the caging knob and rotating it clockwise locks the gyro. Don't lock the standby gyro during flight

F. NATOPS step 18. BIT display - NOTE DEGD: (IFF, YDS and VCR will display DEGD if they are set to OFF or are in standby)
The possible BIT legends are:

1. GO - proper system operating and dual 1553 bus communications

2. OPGO - no BIT failure, but equipment responding on only one 1553 bus

3. DEGD - BIT failure, equipment off, or 1553 bus communication failure on both channels

4. OVRHT - over heat condition detected in DEU

5. IN TEST - equipment in Power up BIT or Initiated BIT

IV. Abnormal starts **1.5.3.1.2.3**

A. Wet Start — there is an indication of fuel flow but EGT and rpm don't increase after 15 seconds from moving the throttle to idle you have a WET START

B. HUNG Start — RPM stagnates below 45% while EGT continues to rise toward the starting limit of 550 degrees C you have experienced a HUNG start

C. HOT Start — there is an indication of fuel flow and rpm increasing normally but EGT is rapidly approaching 550 degrees or will overshoot 570 degrees for more than 10 seconds you have a HOT start

D. NO READY ADVISORY — if the READY advisory light doesn't illuminate within 15 seconds of placing the ENGINE switch to START it indicates that N_1 is not rotating in the correct direction or is less than 100 rpm

E. OIL PRESS warning light — if the OIL PRESS warning light fails to go out or illuminates during the start sequence it indicates inadequate oil pressure differential

F. FIRE warning light — the FIRE warning light indicates an engine bay fire has been detected. The MASTER ALERT caution light flashes and the warning tone will accompany the warning light

G. GTS FIRE warning light — the GTS FIRE warning light indicates a GTS bay fire has been detected. The MASTER ALERT caution light flashes and the warning tone will accompany the warning light

H. GTS and READY advisory light remaining on — if the GTS or READY advisory lights do not extinguish with engine rpm above 45%, the GTS and engine ignition have not shut down; this is an unacceptable condition for engine start

SUMMARY

The prestart checks ensure the aircraft is configured to start. Engine start is accomplished by momentarily pressing the GTS start button. This causes the gas turbine starter to start and accelerate to idle speed, illuminating the GTS advisory light. When the ENGINE switch is set to START the GTS accelerates to full power and the start valve is open to allow the GTS to supply low pressure air to the air turbine starter which rotates the N_1 shaft. When airflow through the engine starts turning the N_1 shaft in the correct direction at greater than 100 rpm the READY advisory light illuminates. With the READY advisory light illuminated and with engine rpm between 15 and 20 percent, the throttle is moved to ground idle. Failure of the READY advisory light to illuminate after placing the ENGINE switch to START indicates that the engine is not ready to start.

Monitor EGT and rpm gauges during engine start for indications of abnormal operation. No rise in EGT within 15 seconds after moving the throttle to idle is an indication of a wet start. Stagnated rpm below 52% and EGT approaching the starting limits indicates a hung start. A rapid increase in EGT that appears likely to exceed the maximum start EGT limit is an indication of a hot start. An oil pressure failure is indicated by the OIL PRESS warning light not going out or illuminating during the start sequence. An engine fire or GTS fire are indicated by illumination of the FIRE light or GTS FIRE light respectively. If the GTS and READY advisory lights do not go out with the engine rpm above 45% indicates that the GTS and engine ignition has not shutdown.

Poststart checks ensure that all equipment is turned on and is checked for proper operation prior to leaving the line area.

CONCLUSION

Properly following the check list procedures during engine start and recognizing the significance of cockpit indications will significantly increase engine life.

NOTES

LESSON GUIDE

COURSE/STAGE: TS, ADV, & IUT / Cockpit Orientation

LESSON TITLE: Multi-Function Display and Navigation System Operation

LESSON IDENTIFIER: T-45C TS, ADV, & IUT CO-03

LEARNING ENVIRONMENT: CAI

ALLOTTED LESSON TIME: 1.2 hr

TRAINING AIDS:

* Figures

  Fig 1: Weight-on-Wheels BIT Display — Engine Operating
  Fig 2: Aircraft Data Display
  Fig 3: Waypoint Data Display
  Fig 4: ADI Display
  Fig 5: HUD Bingo Fuel Entry
  Fig 6: Waypoint Data Display
  Fig 7: GPS Data Display

STUDY RESOURCES:

* Lesson Guide, Engineering-21, CNI System
* Lesson Guide, Engineering-23, Display System and Malfunctions
* T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

(10-99) CHANGE 1

LESSON PREPARATION:

Read:

* Communications - Navigation Equipment and Procedures in Part VII Chapter 21, in the T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

Review:

* Lesson Guide, Eng-21 CNI System
* Lesson Guide, Eng-25 Display System and Malfunctions

REINFORCEMENT: N/A

EXAMINATION:

The objectives in this lesson will be tested in the simulator and the aircraft.

LESSON OBJECTIVES

1.4.18.4.1
Demonstrate procedures for checking/testing the display system

1.7.9
Demonstrate procedures for entering basic mission data into the Multi-Function Display

2.7.5.1.1.1
Recall function and use of TACAN, VOR, VOR/DME controls and indicators

2.7.5.1.1.1.2
Recall procedures for tuning/identifying TACAN, VOR, VOR/DME stations

MOTIVATION

The Multi-Function Display (MFD) is the source for flight, navigation, system health, and system management information. You need to be intimately familiar with its operation.

OVERVIEW

This lesson builds on your understanding of the digital display and navigation systems presented in Engineering. The procedures for running a display system BIT and entering basic mission data is introduced. In addition you will initiate a BIT, enter basic mission data, tune and identify navigation aids.

REFRESHER

The nucleus of the T-45C avionics architecture is the Display Electronics Unit (DEU). It functions as both a display and mission computer.

The display computer portion of the DEU interprets the Data Entry Panel and Multi-Function Display push-button inputs and generates displays for the four MFDs and the Head Up Display (HUD).

The mission computer portion of the DEU computes navigation and weapon delivery solutions, and interfaces with other aircraft system over the MIL-STD-1553B, multiplex data bus (MUX bus) or hardware interfaces.

PRESENTATION

I. Check/test display system **1.4.18.4.1**

A. T-45C BIT system

1. Four types of BIT

a. Power-up BIT (PBIT): The power-up BIT (PBIT) is the most extensive and is automatically initiated when electrical power is applied with weight-on-wheels

b. Initiated BIT (IBIT)

(1) The Display BIT is a combination of an IBIT of the DEU and an IBIT and Manual BIT (MBIT) of the HUD and MFD

(2) The initiated BIT, IBIT, is similar to the PBIT but it is less extensive. The IBIT must be initiated by the pilot and can only be performed with weight-on-wheels because it interrupts the normal operation of the equipment

c. Manual BIT (MBIT)

(1) The manual BIT (MBIT) may be performed on the following equipment: Data Entry Panel, IFF, Multi-Function Display, TACAN, UHF/VHF, VOR/ILS, and Yaw Damper System (YDS)

(2) The MBIT interrupts the normal operation of the equipment and requires the pilot to observe the results because they may not be reported on the BIT display

Fig 1: *Weight-On-Wheels BIT Display -- Engine Operating*

d. Continuous BIT (CBIT)

(1) The continuous BIT is the least extensive BIT and is performed as background testing during normal equipment operation

(2) When the continuous BIT detects a degraded condition an AV BIT indication is displayed on all MFDs

2. AUTO BIT

a. The AUTO BIT and ADR IBIT legends are only displayed when the engine is not running. Therefore you will normally never see this display

a. Upon selection of AUTO the DEU enters IBIT. Upon completion of the DEU IBIT, the ADR, GINA and MDL enter IBIT simultaneously. The radar altimeter enters IBIT when the ADR IBIT is completed

II. Enter basic mission DATA **1.7.9**

A. Alignment progress check and waypoint zero entry

Fig 2: *Aircraft Data Display*

1. Alignment progress checked on ACFT DATA display

NOTE: On the initial selection of DATA, the format defaults to the waypoint data, subsequent selections of DATA will return to the last selected sub-level data format.

a. Since an alignment takes about two and a half minutes and starts when battery power is applied the system should be aligned by the time you get to aircraft data display on the post-start checks

b. If the alignment QUAL is not decreasing or the system is not tracking four satellites, GPS SAT, waypoint zero must be entered

2. Waypoint zero entry: Enter waypoint zero latitude and longitude. Unless waypoint zero is going to be used for CCIP bombing, elevation doesn't need to be entered. MVAR only needs to be entered if it is wrong

Fig 3: *Waypoint Data Display*

3. Fifty seconds after entering waypoint zero verify that the QUAL is decrementing on the aircraft data display

NOTE: You don't need to monitor this display if the QUAL number is decreasing and the GPS is tracking four satellites.

B. BINGO and LAW setting: the low altitude warning (LAW) and BINGO settings are displayed and changed from the ADI display

Fig 4: *ADI Display*

1. The low altitude warning, LAW, defaults to 500 feet and the BINGO, BNGO, defaults to 900 pounds on start

2. The LAW and BINGO can be changed in two ways on the ADI display or with the DEP on the HUD

a. ADI data entry: select desired parameter, LAW or BNGO and use the increment or decrement number to change the setting

(1) BNGO can be set between 0 and 3,000 pounds in 100 pound increments

(2) LAW can be set between 0 and 5,000 feet in 10 foot increments

Fig 5: *HUD BINGO Fuel Entry*

b. DEP data entry: select BNGO or LAW

(1) Scratch pad with current LW or BF setting displayed

(2) If entered data is not valid it will flash — press CLR and reenter LAW or BNGO data

(3) The entered number will be rounded down to 100 pound for BINGO or 10 feet for LAW increments when ENT is pressed

C. Compare MFD displays with standby instruments

1. Compare the heading on the ADI, HSI and HUD with the standby compass

2. Compare the attitude on the ADI and HUD with the standby attitude indicator

3. Compare the airspeed on the ADI and HUD with the standby airspeed indicator

NOTE: The minimum airspeed recognized and displayed by the DEU on the ADI and HSI is 50 knots.

4. Compare the altitude on the ADI and HUD with the standby altimeter

NOTE: Set the standby altimeter to field barometric pressure. Ensure that the error is not more than +/- 75 feet. The standby altimeter also sets the barometric pressure for the DEU.

5. The BIT display is checked for the results of the power-up BIT

D. Waypoints Program

1. A maximum of eleven waypoints can be entered, ten tactical waypoints plus waypoint zero with waypoint zero reserved for home plate

2. Waypoint data entry: waypoints can be programmed manually from the waypoint data display or transferring waypoints from the mission data loader to a tactical waypoint from the GPS data display

Fig 6: Waypoint Data Display

a. Manual waypoint data entry is done on the waypoint DATA display

(1) Press LAT, LONG, ELEV or MVAR to enable the scratchpad and enter data using the HUD data entry panel

(2) A N or S must be entered first when entering latitude

(3) A W or E must be entered first when entering longitude and magnetic variation

(4) A positive sign is required for positive elevations

b. Transferring waypoint data from the DEU to an active waypoint is done on the GPS DATA display

(1) The GPS data page allows you to select from up to 200 waypoints stored in the MDL. The first 15 waypoints are transferred to the DEU on power up.

Fig 7: GPS Data Display

(2) Select the desired waypoint

(3) Select the desired waypoint in the GPS waypoints displayed or select another page for more GPS waypoints

(4) When the desired GPS waypoint is in the GPS waypoint data block select XFER to transfer the data to the active waypoint

(5) A successful transfer is indicated by the waypoint data in both the GPS data block on the lower left and the tactical waypoint data block on the lower right are the same

E. Set navigation source **2.7.5.1.1.1**

1. The navigation source TCN, VOR or WYPT must be selected on the HSI display (VOR is not a selection option with PLAN selected)

2. When course and a navigation source are selected the bearing pointer and a course line are displayed on the HSI and the steering arrow is shown on the HUD

3. Command course and heading: the command course and heading can be set either with the increment decrement push-buttons on the HSI display or with the buttons on the DEP

4. Compass rose scale: There are five scales 10, 20, 40, 80, and 160 miles with each depression of the scale push-button the compass rose scale decreases

F. Tune and identify navigation aids **2.7.5.1.1.1.2**

1. Though there is no set order for tuning and identifying navigation aids, the following should be accomplished:

    a. Determine the NAVAIDS frequency or channel and identification

    b. Tune the station on the TACAN or VOR/ILS control panel

    c. Identify the station by selecting the TACAN or VOR switch on the communications control panel

    d. The navigation aids voice or morse code ID for VOR or morse code for TACAN or VOR/ILS is now routed to the headsets

G. Cockpit resource management

1. Effective cockpit resource management involves setting task priorities and continuing to fly the aircraft. This is especially important during heavy cockpit workloads, e.g., during an instrument approach

2. Part of your cockpit management plan should be an established procedure for tuning and identifying TACAN, VOR, and ILS stations

3. Do as much as possible prior to the terminal phase of the instrument approach so you can concentrate on flying the approach

4. A suggested sequence for setting up the navigation equipment (your procedures may differ) is:

   a. Determine the NAVAIDS frequency or channel and identification

   b. Ensure you have NAV control in your cockpit

   c. Tune and identify the station

   d. Ensure you have the desired steering selected

   e. Set desired course and heading on the HSI

   f. Tune and identify a back up navigation aid if available

SUMMARY

Being intimately familiar with the Multi-Function Display and Navigation equipment operation is important and is an important part of developing an effective cockpit resource management plan.

Your cockpit management plan should be an established procedure for handling flying, navigating, and communicating tasks. The more effective you are at managing the navigation and communication tasks the more time you will have to do the most important task — fly the aircraft.

CONCLUSION

In this lesson you learned about the Display System BIT, how to tune and identify navigation aids, and how to select a steering source on the HSI display. You will use these skills on every simulator and aircraft flight.

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FIGURES

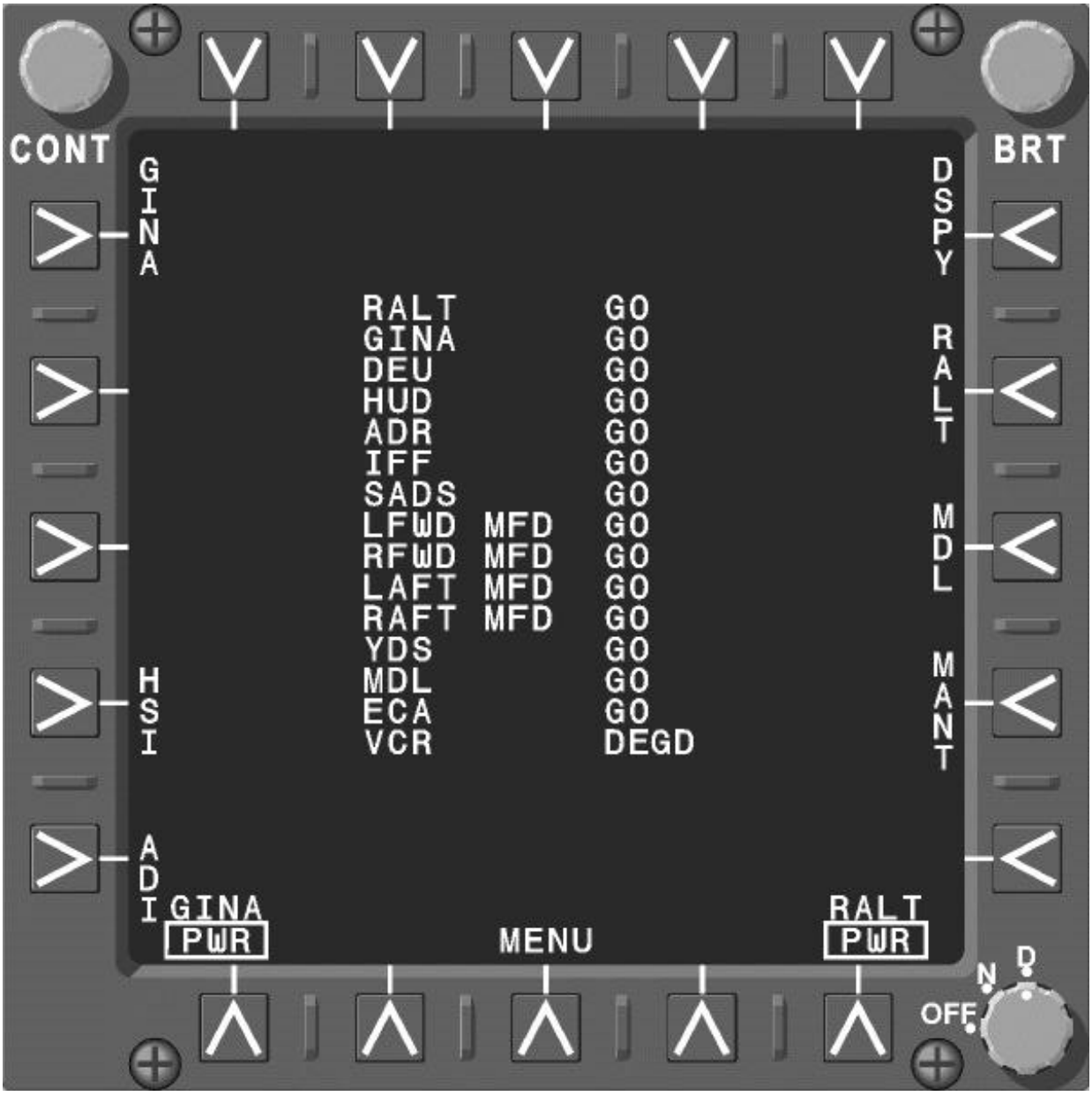


Figure 1: WEIGHT-ON-WHEELS BIT DISPLAY -- ENGINE OPERATING

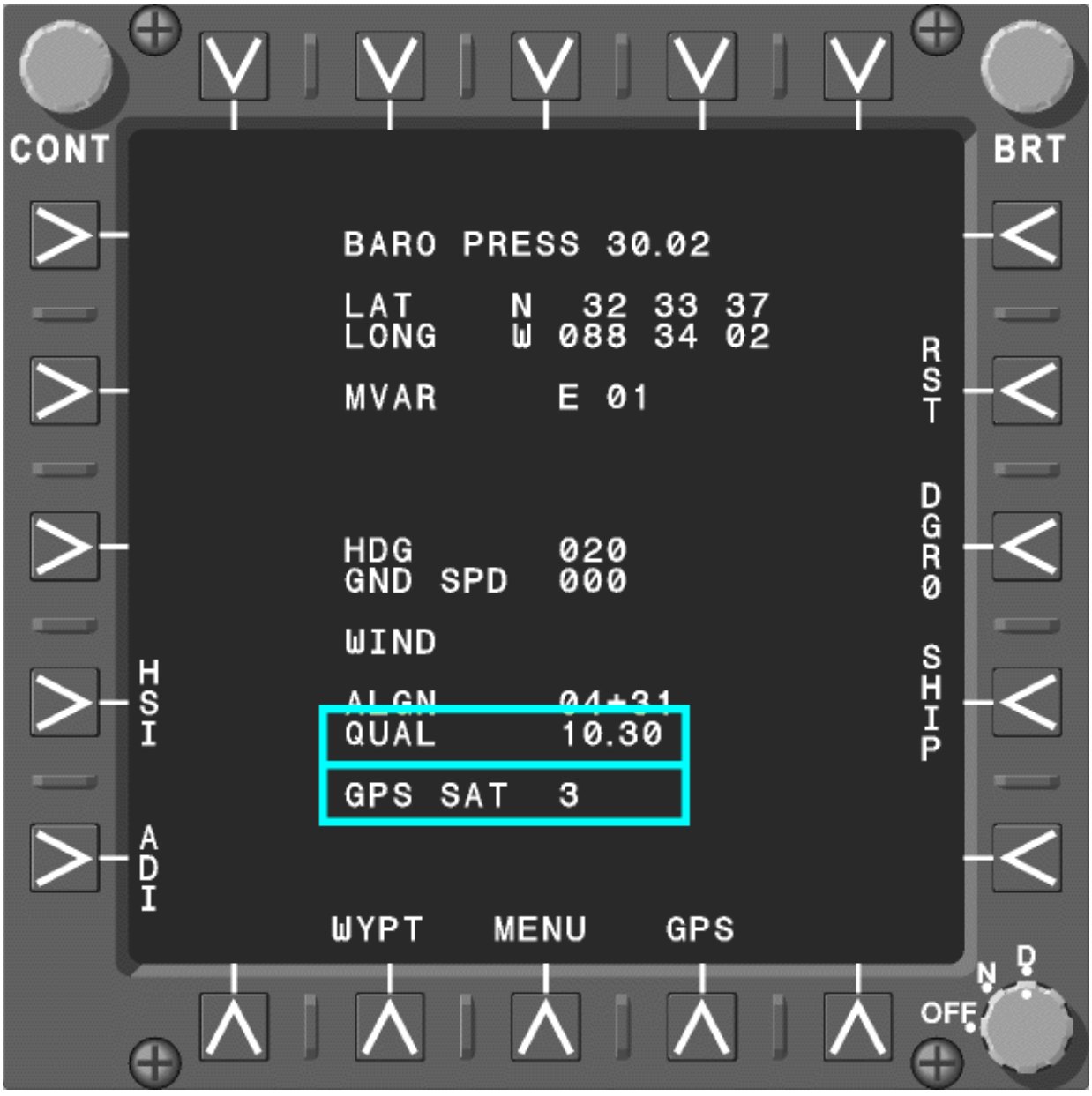


Figure 2: AIRCRAFT DATA DISPLAY

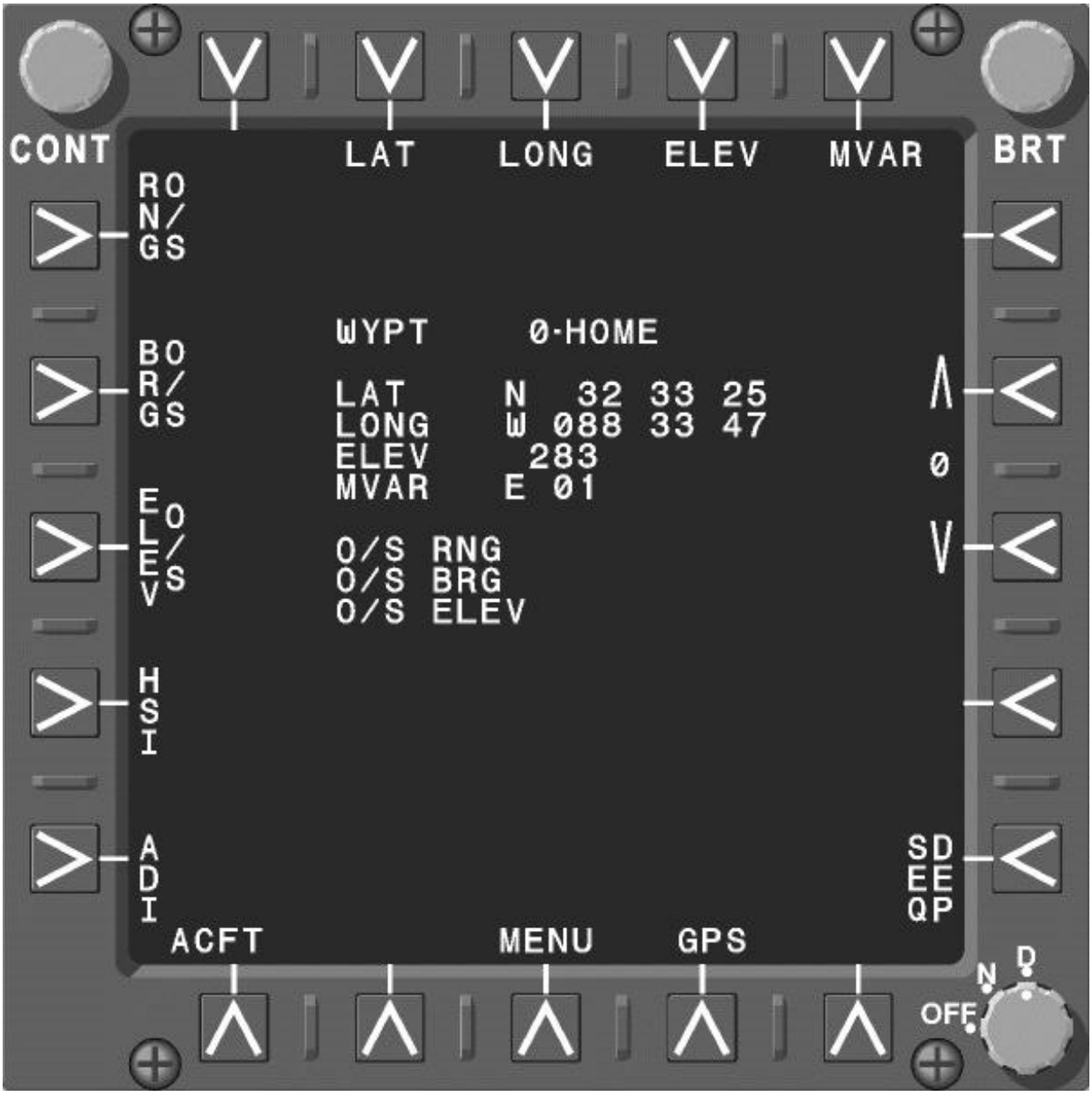


Figure 3: WAYPOINT DATA DISPLAY

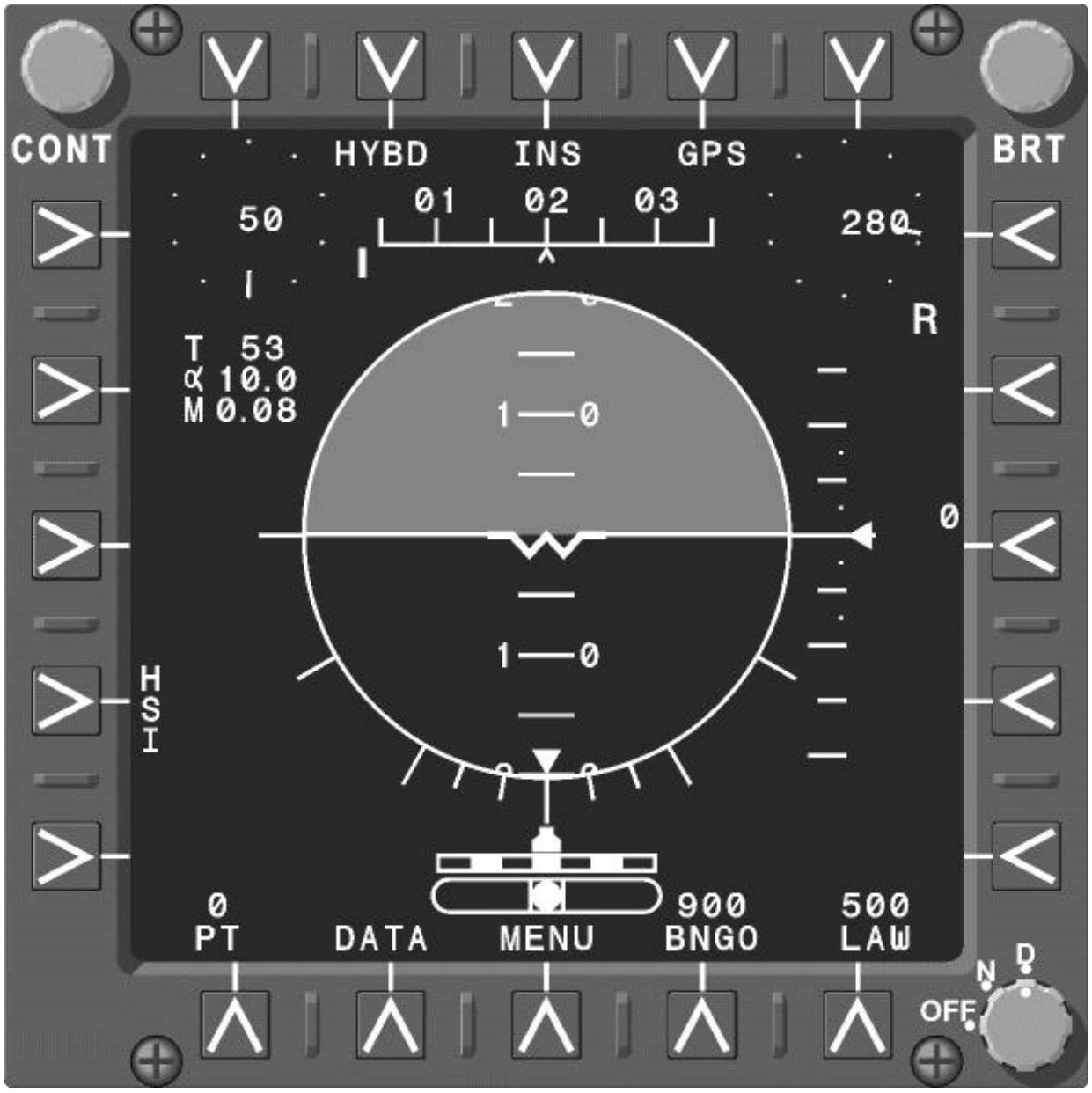


Figure 4: ADI DISPLAY

Figure 5: HUD BINGO FUEL ENTRY

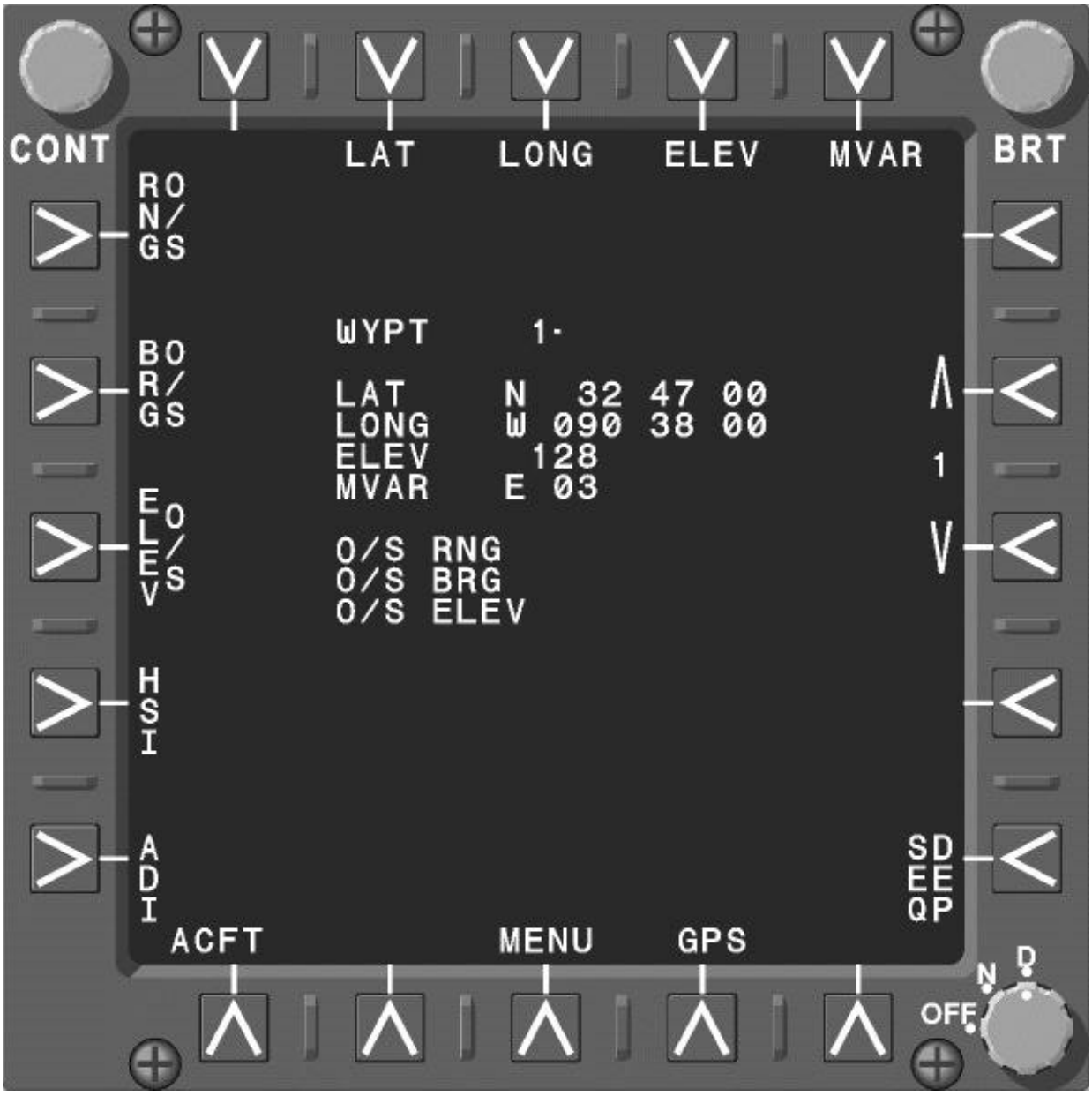


Figure 6: WAYPOINT DATA DISPLAY

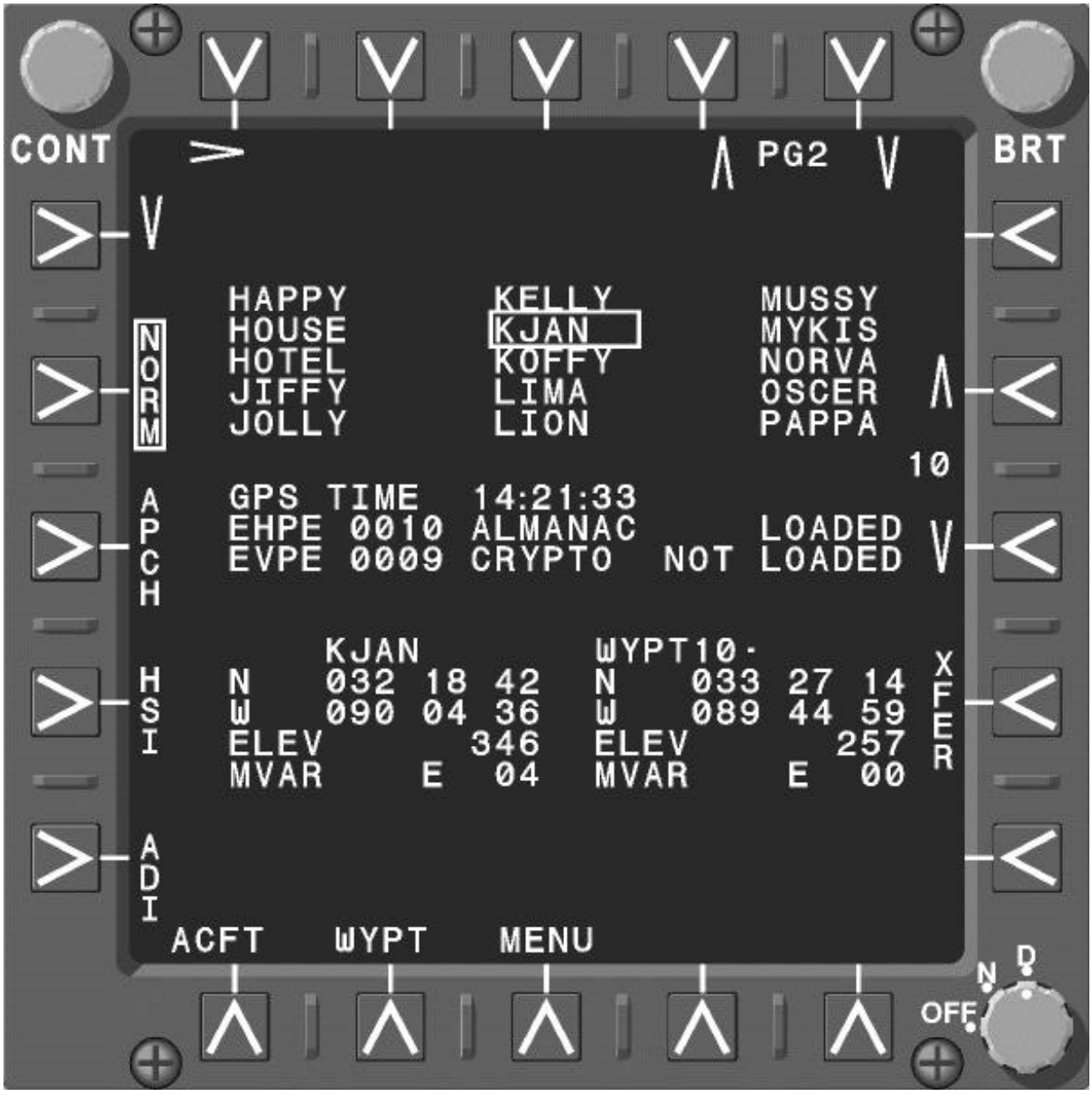


Figure 7: GPS DATA DISPLAY

LESSON GUIDE

COURSE/STAGE: TS, ADV, & IUT / Cockpit Orientation

LESSON TITLE: Display System (HUD)

LESSON IDENTIFIER: T-45C TS, ADV, & IUT CO-04

LEARNING ENVIRONMENT: CAI

ALLOTTED LESSON TIME: 0.8 hr

TRAINING AIDS:

* Figures

  Fig 1: HUD Navigation Master Mode
  Fig 2: Navigation Cruise Declutter
  Fig 3: Navigation Approach Declutter
  Fig 4: Air-to-Air Declutter
  Fig 5: Air-to-Ground Declutter
  Fig 6: HUD Test Pattern

STUDY RESOURCES:

* Lesson Guide, Engineering-23, Display System and Malfunctions
* Lesson Guide, Cockpit Orientation-03, Display and Navigation System Operation
* T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

(10-99) ORIGINAL

LESSON PREPARATION:

Read:

* "Head-up Display", Part I, Chapter 2, Paragraph 2.4.3.5, in the T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

Review:

* Lesson Guide, ENG-25 Display System and Malfunctions
* Lesson Guide, Cockpit Orientation-03, Multi-Function Display and Navigation System Operation

REINFORCEMENT: N/A

EXAMINATION:

The objectives in this lesson will be tested in the simulator and the aircraft.

LESSON OBJECTIVES

4.4.5.3.2
Recall conditions when cruise/approach submodes activated

4.4.5.1.3
Recall characteristics of HUD symbology

4.4.5.3.3
Recall procedures to enter declutter mode

4.4.5.2.1
Recall function of HUD test modes

4.4.5.4.2
Identify HUD BIT codes

4.4.5.2.2
Demonstrate procedures for check/test of HUD

MOTIVATION

The Head-Up Display (HUD) is the source for flight, navigation, and weapon system aiming, so you need to be intimately familiar with its operation.

OVERVIEW

The Head-Up Display (HUD) allows you to perform essential scan in situations where your eyes must be out of the cockpit. For VFR navigation, or later in air-to-air/air-to-ground, you will find the HUD an invaluable tool in getting the job done.

This lesson covers the components and controls of the HUD, and interfaces between the HUD and other aircraft systems.

REFRESHER

The T-45C HUD system is a basic Head Up Display (HUD).

It provides heading, attitude, altitude, airspeed, AOA, g, weapons aiming and actual aircraft flight path information.

You learned the location of the HUD components in Engineering. In this refresher, you'll find out how much you remember.

PRESENTATION

I. Cruise/Approach Submode Selection and Master Mode Selection **4.4.5.3.2**

A. There are three master modes

1. Navigation - the default display on ground start

a. Approach submode selected when landing gear handle is down

b. Cruise submode selected when landing gear handle is up

2. Air-to-air

a. Lead Angle Computing (LAC) submode is selected on the air-to-air stores display

b. Real Time Gun Sight (RTGS) submode is selected on the air-to-air stores display

3. Air-to-ground

a. Manual (MAN) submode is selected on the air-to-ground stores display

b. Continuously Computed Impact Point (CCIP) submode is selected on the air-to-ground stores display

c. Weapon and station selection are also made on the air-to-ground stores display

Fig 1: *HUD Navigation Master Mode*

II. HUD Navigation Symbology **4.4.5.1.3**

A. Velocity vector

1. Provides an indication of the actual aircraft flight path whenever the AOA and INS data are valid

2. Limited to +/- 7° laterally from the HUD centerline and + 3° - 11° vertically from an imaginary line between the airspeed and altitude box

3. When caged, the velocity vector is restricted to near the HUD PDU center line. The actual aircraft flight path is shown by a ghost velocity vector

4. The velocity vector defaults to caged in Navigation and A/A and to uncaged in A/G master mode

5. Pressing the CAGE/UNCAGE button on the stick grip will cycle the velocity vector between caged and uncaged

6. The caged velocity vector is placed on the HUD where a line from the ghost velocity vector parallel to the horizon line intersects a line perpendicular to the horizontal flight line

7. The velocity vector or ghost velocity vector will flash when their display limits are exceeded

B. Pitch ladder and horizon line

1. Positive pitch has solid lines, while negative pitch has dashed lines

2. Pitch angle lines become more acute as pitch angle increases, and they always point at the horizon

3. Horizon line is indicated by a larger, unlabeled bar

C. Bank scale and pointer

1. Scale marks 0, 5, 15, 30, and 45 degrees of bank

2. The bank angle pointer flashes when AOB exceeds 47.5 degrees and is removed at AOB greater than 90 degrees

D. Heading scale

1. Heading is indicated by the heading marker in the center referenced to a moving 30 degree wide heading scale that has digital readings every 10 degrees

2. As the aircraft turns right, the scale moves from right to left

E. AOA

1. AOA bracket displays only in approach. It moves up and down in relation to the velocity vector

2. When the AOA bracket moves beyond the velocity vector, below 16 or above 18 units the digital AOA indication displays

3. Digital AOA is always displayed in navigation cruise submode and in air-to-air and air-to-ground master modes

F. Indicated airspeed

1. Displayed in one knot increments

2. Minimum airspeed is 50 knots

G. Vertical speed

1. Climb rates of up to +/-9,990 feet per minute in 10 foot increments

2. Determined from GINA accelerometers and is independent of the pitot static system

H. Barometric altitude

1. Displayed in 20 foot increments from -1,000 to 53,000 feet MSL

2. DEU adjusts altitude for the barometric setting entered on the standby altimeter

I. Radar altitude

1. Is displayed in 10 foot increments

2. Digital altitude displayed up to 4,990 feet AGL

3. Digital altitude removed above 5,000 feet AGL or signal is lost

4. Digits and the "R" are removed when the radar altimeter is turned off

J. Selected steering mode, distance, and time-to-go

1. Steering data displayed when steering mode is selected on HSI display

2. Steering mode acronyms

a. TCN — TACAN steering

b. W## — Waypoint steering and waypoint number

c. O## — Waypoint offset steering and waypoint number

d. VOR — VOR steering

e. ILS — ILS only steering

f. TILS — TACAN and ILS steering

g. WILS — Waypoint and ILS steering

h. OILS — Waypoint offset and ILS steering

3. Distance and time-to-go resolution is commensurate with information displayed on the HSI

K. Situation steering arrow and reference dots

1. Displayed when TACAN, waypoint, or waypoint offset is the selected steering source and course (CRS) is selected on the HSI

2. Each reference dot represents 5 degrees of course deviation with TACAN steering

3. Each reference dot represents 2 nm gear up, or 0.15 nm gear down, cross track deviation with waypoint or waypoint offset steering

4. The reference dots are removed when the deviation from the selected course is with 1 degree with TACAN selected of .4 nm gear up, 0.03 nm with gear down with waypoint or waypoint offset selected

L. ILS needles

1. Displayed whenever ILS is selected steering and an ILS signal is received

2. Needles are referenced to the velocity vector and scaling is commensurate with the scaling on the ADI display

3. Needles will flash when the glideslope and/or localizer needle display limits are reached

M. Command heading bug

1. Only shown when the course steering arrow is not displayed

2. Slides slightly past the heading scale on the side that represents the shortest turn to the command heading

N. Caution and warning

1. Caution symbol is displayed in the scratchpad whenever a caution light illuminates on the warning, caution, advisory panel

2. Caution also displayed when the fuel quantity falls below the BINGO fuel setting

3. Warning “W” is displayed in the center of the HUD whenever a warning light illuminates on the warning panel

4. Warning “W” is also displayed when the radar altitude goes below the LAW setting

5. When activated by reaching bingo fuel or LAW radar altitude the caution or warning “W” are removed by pressing the push-button next to REJ on any MFD

6. With gear down the LAW activated warning “W” will flash for 3 seconds and then disappear

O. Water line

1. Only displayed when the AOA is invalid or the system is not aligned

2. When displayed the pitch attitude, ILS needles, and steering arrow are referenced to the water line symbol

P. Unique symbols

1. Ground speed — is only displayed in navigation cruise submode

2. Mach number — is displayed on all HUD displays except navigation approach

3. Normal g and peak g

a. Indicates aircraft acceleration between +/- 9.8 g's in 0.1 g increments

b. G appears in all master modes except for navigation gear down

c. Positive peak g is displayed anytime g exceeds 4.0

d. Peak g removed/reset by selecting declutter 1 from normal

4. GPS time

a. Coordinated Universal Time (UTC) is displayed in lower left corner of the pilot's total field-of-view in navigation master mode

b. Format is hh:mm:ss

III. Declutter **4.4.5.3.3**

A. Declutter (DCL) push-button on DEP is used to cycle between the normal display and two declutter levels

B. Navigation cruise declutter levels

Fig 2: *Navigation Cruise Declutter*

1. Declutter 1 removes — ground speed, angle of attack, mach number, and normal g loading

2. Declutter 2 removes — all symbols removed in declutter 1 plus the heading scale, heading carrot, bank scale and bank pointer

Fig 3: *Navigation Approach Declutter*

C. Navigation approach declutter levels

1. Declutter 1 removes — digital angle of attack

2. Declutter 2 removes — digital angle of attack, heading scale, heading carrot, bank scale and bank pointer

Fig 4: *Air-to-Air Declutter*

D. Air-to-air declutter levels

1. Declutter 1 removes — angle of attack, mach, and normal g loading

2. Declutter 2 removes — all symbols removed in declutter 1 plus the heading scale and heading carrot

Fig 5: *Air-to-Ground Declutter*

E. Air-to-ground declutter levels

1. Declutter 1 removes — angle of attack, mach, normal g loading

2. Declutter 2 removes — all symbols removed in declutter 1 plus the heading scale and heading carrot

IV. Check/Test HUD **4.4.5.2.1, 4.4.5.4.2, 4.4.5.2.2**

A. Four types of BITs test display system

1. Power-up BIT (PBIT)
2. Continuous BIT (CBIT)
3. Initiated BIT (IBIT)
4. Manual BIT (MBIT)

B. Power-up BIT

1. HUD and MFD blank during DEU power-up BIT
2. HUD BIT status displayed on BIT status display

C. Display BIT

1. Combination of initiated and manual BIT
2. Started by pressing DSPY push-button on BIT status display
   a. HUD and all four MFDs go blank
   b. In 15 seconds HUD test pattern appears
   c. In 50 seconds MFD test pattern appears
3. Check HUD test pattern
   a. Steady
   b. In focus
   c. Centered horizontally
   d. Scratchpad displays T-45A

Fig 6: *HUD Test Pattern*

4. HUD manual BIT

   a. Press all DEP push-buttons

      (1) Number 0-9 — selected number in scratchpad

      (2) DCL — DCL in scratchpad

      (3) ENT — ENT in scratchpad

      (4) SETDEP+ — SETDEP+ in scratchpad

      (5) SETDEP- — SETDEP- in scratchpad

      (6) LAW, CRS, HDG, BNGO — T-45A in scratchpad

   b. MODE — PW in scratchpad

      (1) Maintenance use only

      (2) Without a password DEP buttons lockup and display BIT must be started again

   c. Press CLR to end HUD manual BIT

   d. Press STOP on MFD to end display BIT

   e. Check HUD status on BIT status display

      (1) GO — HUD is operating and no BIT failure

      (2) DEGD — HUD has a BIT failure or is OFF

f. HUD status DEGD

(1) HUD not required for all flights

(2) Check with instructor or operations duty officer if flight can continue with a degraded HUD

SUMMARY

There is a lot of information presented on the HUD display. Knowing what is available and how to interpret the information will help you perform maneuvers with precision.

To avoid HUD fixation, maintain a good outside and inside scan.

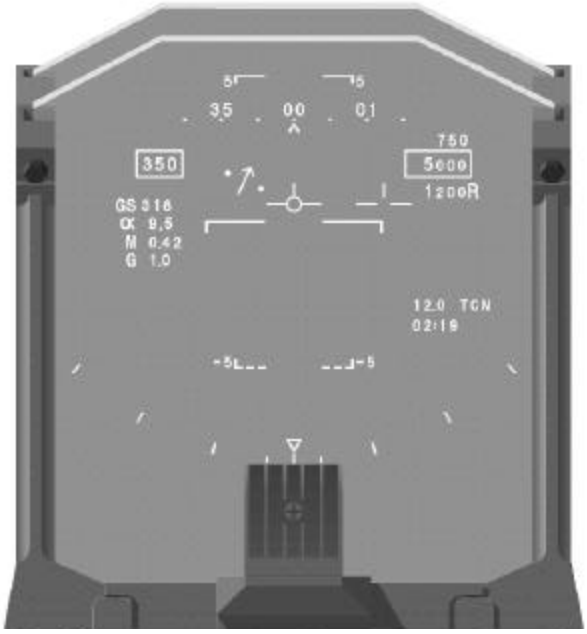
The HUD shall not be used as a primary flight instrument.

CONCLUSION

Knowing the HUD operation and recognizing the significance of cockpit indications are essential to aircraft control and mission completion. Knowledge of the aircraft, its systems, normal operation, and malfunctions is imperative to safe operation.

FIGURES

CRUISE



APPROACH

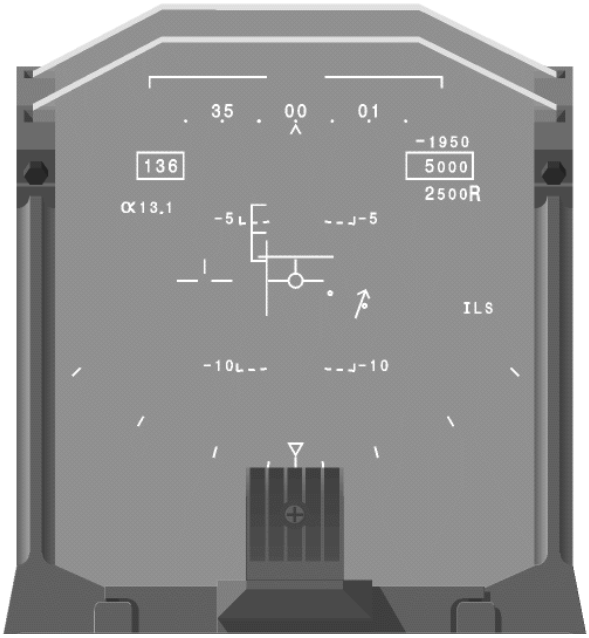
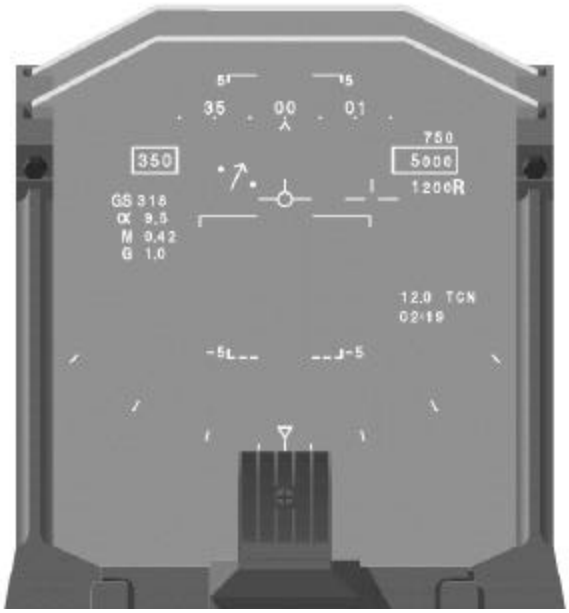
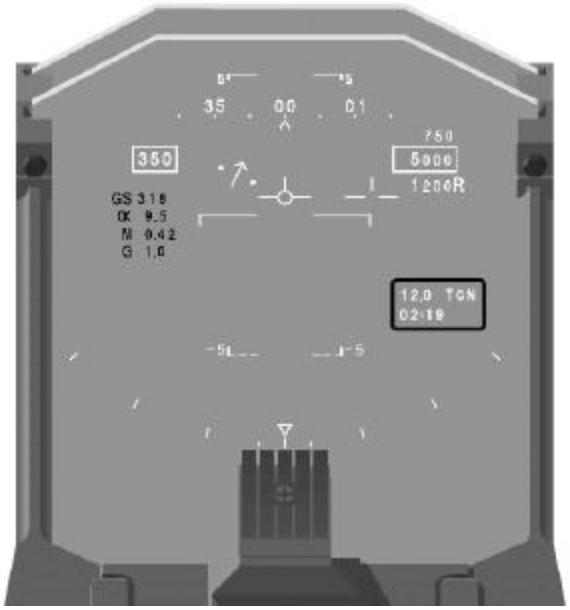


Figure 1: HUD NAVIGATION MASTER MODE

NORMAL



DECLUTTER-1



DECLUTTER-2

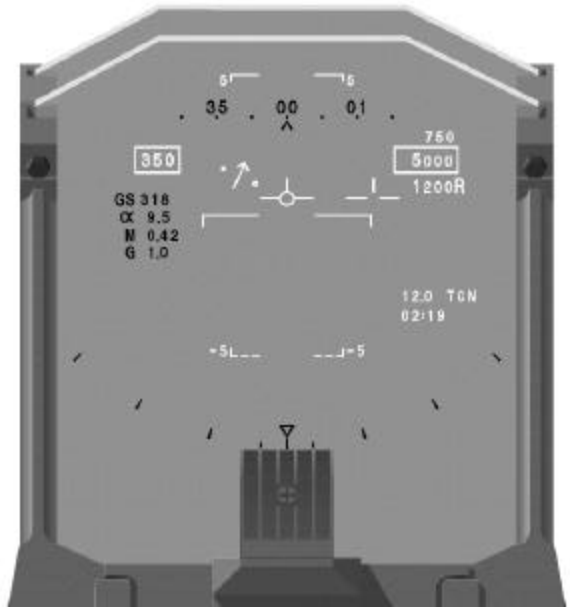


Figure 2: NAVIGATION CRUISE DECL ITTER

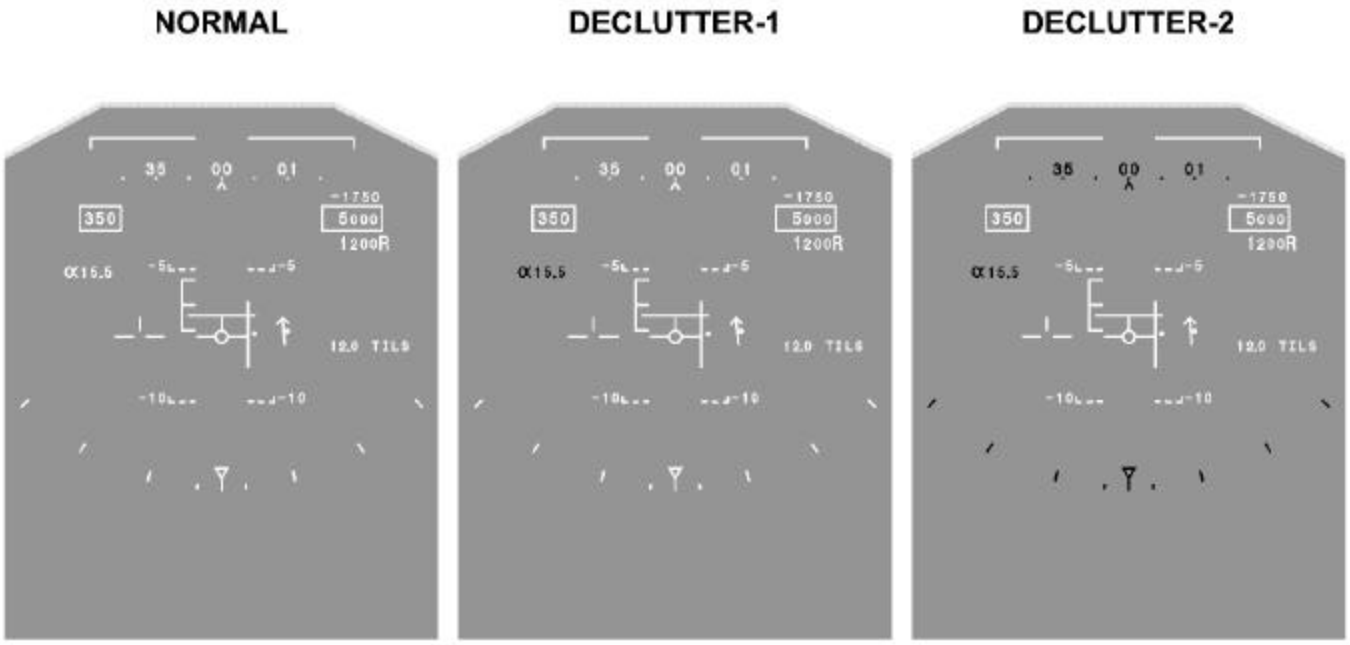


Figure 3: NAVIGATION APPROACH DECLUTTER

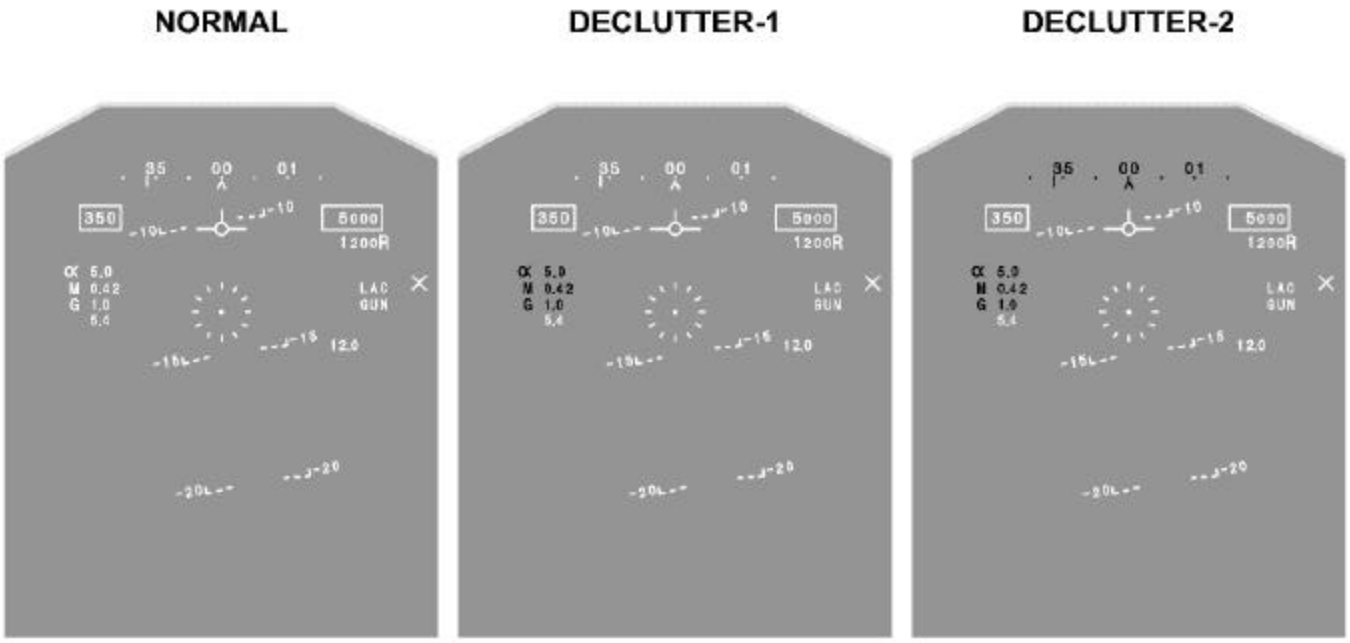


Figure 4: AIR-TO-AIR DECLUTTER

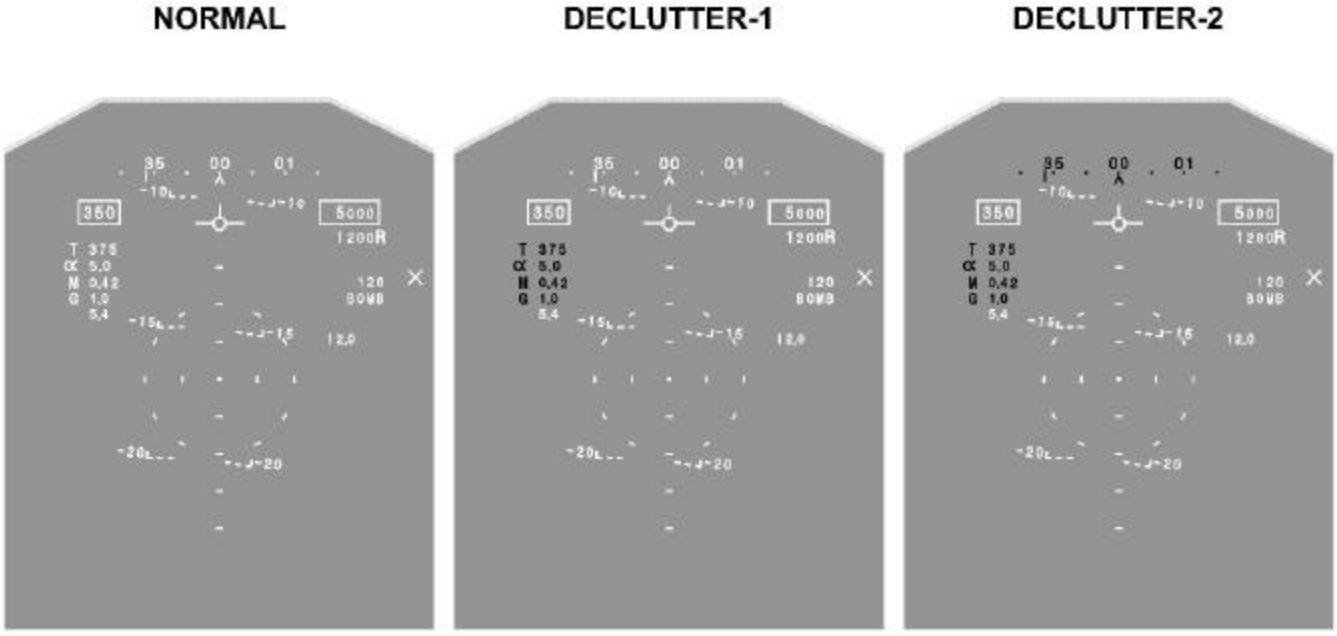


Figure 5: AIR-TO-GROUND DECLUTTER

Figure 6: HUD TEST PATTERN

NOTES

LESSON GUIDE

COURSE/STAGE: TS, ADV, & IUT Cockpit Orientation

LESSON TITLE: Waypoint Navigation Procedures

LESSON IDENTIFIER: T-45C TS & ADV CO-05; IUT NAFP-01

LEARNING ENVIRONMENT: CAI

ALLOTTED LESSON TIME: 1.2 hr

TRAINING AIDS:

* Figures
  - Fig 1: Plan Mode With No Steering
  - Fig 2: CDI Mode With No Steering
  - Fig 3: HUD View With Waypoint Steering
  - Fig 4: SEQ Option With No Steering - Plan
  - Fig 5: SEQ Option With WYPT Steering - Plan
  - Fig 6: SEQ Option With WYPT Steeriing and CRS - Plan
  - Fig 7: AUTO Option Without SEQ - Plan
  - Fig 8: AUTO Option With SEQ and CRS - Plan
  - Fig 9: Waypoint Data Display Page - 1
  - Fig 10: Waypoint Data Display Page - 2
  - Fig 11: GPS Data Display Page - 1
  - Fig 12: GPS Data Display Page - 2
  - Fig 13: Waypoint String Entry Using DEP
  - Fig 14: Global Positioning System/Inertial Navigation Assembly (GINA)
  - Fig 15: Display Electronics Unit (DEU)

(10-99) ORIGINAL

STUDY RESOURCES:

* T-45C NATOPS Flight Manual, A1-T45AC-NFM-000
* Lesson Guide for Engineering, "Display System and Malfunctions"

REINFORCEMENT: N/A

EXAMINATION:

The objectives in this lesson will be evaluated during simulator and aircraft events.

LESSON OBJECTIVES

2.7.7.2.1
Recall procedures for performing IFR waypoint navigation

4.4.5.3.1
Recall procedures for entering navigational data

4.7.2.2.3
Interpret navigation symbology of HUD

2.8.1.1.2.1
Identify indications of erroneous INS data

2.8.1.1.3.1
Identify indications of excessive INS drift

2.8.1.1.1
Recall procedures for INS failure

2.8.2.1.1
Recall procedures for display unit failure

MOTIVATION

Using the T-45C waypoint system will make your navigation requirement an easier task. Maintaining situational awareness is also made easier by the waypoint system. It provides you with timely data and map-like depictions.

OVERVIEW

The goal of this lesson is to comprehensively inform you regarding the following:

* Introduction to waypoint navigation
* Entering set-up data
* Navigating with the waypoint system
* Systems malfunctions

PRESENTATION

I. Introduction to waypoint navigation **2.7.7.2.1**

A. Definitions

1. Area navigation permits aircraft operation on any desired course

2. Global positioning system is world-wide, space-based satellite system for positioning and navigation

3. T-45C Waypoints are predetermined geographical positions defined by Lat/Long coordinates or bearing/range from another waypoint

4. GPS system

    a. US owned

    b. DoD operated from Falcon AFB, CO

    c. Standard Positioning System (SPS) has 100 meter accuracy with 95 percent probability. T-45C has an SPS system

    d. Precise Positioning Service (PPS) requires crypto keys; gives 16 meter accuracy probability

5. Airways

    a. Wide Area Augmentation System (WAAS) to be implemented by FAA

    b. TACANs and VOR/DMEs planned for deactivation by FAA

    c. Civilian GPS usage is extensive

    d. DoD/Navy upgrading aircraft fleets for GPS

B. Capabilities

1. Tactical waypoints (11)

    a. Number 0: home plate

    b. Numbers 1-10: designated by pilot

2. Tactical waypoint offsets (11)

    a. Numbers 0-10 designated by pilot

    b. Range: 0-99.9 nm

    c. Bearing 0-359.9 degrees

3. GPS waypoints (200)

    a. Transferred from MDL

    b. Identifiers

    c. 14 pages

    d. Up to 15 per page (except only 5 on page 14)

C. Accuracy

1. T-45C is SPS certified

2. T-45C can become PPS certified

3. Future enhancements

D. Restrictions

1. GPS waypoints cannot be used as primary navigation system (CNO)

2. GPS is allowed for support of visual navigation (CNO)

3. FAA requires GPS accuracy monitoring equipment for operations on FAA airways system

Fig 1: *PLAN Mode With No Steering*

E. Displays

1. PLAN mode

    a. SEQ

    b. CRS

    c. CRS and WYPT

    d. WYPT

2. CDI mode

   a. SEQ

   b. CRS

   c. CRS and WYPT

   d. WYPT

3. HUD

F. Steering options

1. SEQ option

   a. SEQ (no steering) - PLAN

   b. SEQ (WYPT steering) - PLAN

   c. SEQ (WYPT steering and CRS) - PLAN

2. AUTO option

   a. AUTO (WYPT steering) - PLAN

   b. AUTO (WYPT steering, SEQ, and CRS) - PLAN

   c. Specifics

II. Entering set-up data **4.4.5.3.1**

A. DATA display — WYPT sub-menu

1. DATA page waypoint selection number does not affect current HSI waypoint selection

2. LAT/LONG entries preceded by N, S, E, or W

Fig 2: *CDI Mode With No Steering*

Fig 3: *HUD View With Waypoint Steering*

Fig 4: *SEQ Option With No Steering - PLAN*

Fig 5: *SEQ Option With WYPT Steering - PLAN*

Fig 6: *SEQ Option With WYPT Steering and CRS - PLAN*

Fig 7: *AUTO Option Without SEQ - PLAN*

Fig 8: *AUTO Option With SEQ and CRS - PLAN*

Fig 9: *Waypoint Data Display Page - 1*

Fig 10: *Waypoint Data Display Page - 2*

3. DEP CLR for mistaken entries
4. Required digits for entries
5. ELEV entries preceded by (+) or (-)
6. Scratchpad
7. O/S ELEV limits
8. O/S RNG limits
9. O/S BRG 0 to 359.9
10. O/S RNG entry required for other O/S values to show

Fig 11: *GPS Data Display Page - 1*

Fig 12: *GPS Data Display Page - 2*

B. DATA display — GPS sub-menu

1. 200 waypoints stored in MDL
2. 14 pages/15 per page
3. Select tactical waypoint to overwrite
4. Select XFER to transfer data to tactical waypoint

Fig 13: *Waypoint String Entry Using DEP*

C. Waypoint strings

1. Previous string displayed
2. Boxing DEP SEQ initializes string to zero and allows DEP waypoint entries
3. Use DEP for waypoint number entries followed by ENT for each waypoint in sequence
4. Unboxing DEP SEQ after string entry closes entry sequence

III. Navigating with the waypoint system **4.7.2.2.3**

A. Restrictions

1. CNO
2. FAA

B. Home plate

1. Waypoint 0
2. Can be changed by pilot; not normally done
3. Records aircraft position at power shut-down
4. Used by GINA for initial power-on alignment

C. Record a geographical point

1. Crash site, etc.
2. Present position coordinate on DATA page
3. Bearing/distance reference

D. Find a point

1. Destination
2. Rendezvous point
3. Bombing range target
4. Initial point (IP)
5. Target
6. Refueling orbit
7. Ingress/Egress routes

E. Waypoint sequence string uses

1. Define MOA boundaries
2. Define low-level visual navigation routes
3. Define boundaries of Prohibited, Warning, Danger, etc. areas
4. Define a series of simulated targets
5. Aid to navigation
6. Manual or AUTO mode

IV. Systems malfunctions

A. GINA problems **2.8.1.1.2.1, 2.8.1.1.3.1, 2.8.1.1.1.**

1. Seamless INS and GPS in GINA
2. HYBD mode is normal
3. INS error/drift
4. Loss of attitude platform
5. DGRO mode on ACFT DATA display page
6. BIT display page
   a. Weight-off-wheels format
   b. Weight-on-wheels format
7. GPS mode
8. INS mode
   a. RST
   b. Return to HYBD

Fig 14: *Global Positioning System/Inertial Navigation Assembly (GINA)*

c. GPS CORRIDOR advisory

(1) NORM criteria

(2) APCH criteria

9. GPS fails

a. Determine INS error

b. Determine INS error rate

10. GINA fails

a. AVBIT advisory

b. Lose waypoint and O/S capability

c. Reverts to DGRO mode

d. Enter magnetic heading

e. Recycle GINA with RST

f. Cross-check standby instruments

11. Partial GINA failure

a. Check BIT page for DEGD

b. Attitude information may be OK

c. GINA may attempt an auto-reset for realigning attitude gyros. Hold straight/ level/unaccelerated flight for the 30-45 seconds

d. GINA may self-align for position and heading resolution

Fig 15: *Display Electronics Unit (DEU)*

B. DEU problems **2.8.2.1.1**

1. Total failure
2. Partial failures
3. Generator under-voltage two minute timer for DEU, SADS, DEP, FWD/AFT MFDs
4. HUD and RGT MFDS remain unpowered
5. MFDs default to ADI display
6. Selecting ORIDE on display power panel
7. Returning to NORMAL on display power panel

SUMMARY

This lesson has discussed waypoint navigation procedures including the following:

* Introduction
* Entering set-up data
* Navigating with the waypoint system
* Systems malfunctions

CONCLUSION

Waypoint navigation (area navigation) off traditional airway structures is the coming thing. FAA has an implementation plan that is now in progress. During your aviation career increasingly sophisticated navigation computer systems will evolve that incorporate a host of waypoint tools. However, never forget that any navigation system is only as good as the data the pilot enters, and how well he/she employs the system.

Maintaining situational awareness is as important as ever. Also, in a rather bizarre way as pilot workloads are reduced by computers, cockpit complacency can more easily creep into the scene. Stay aware!

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FIGURES

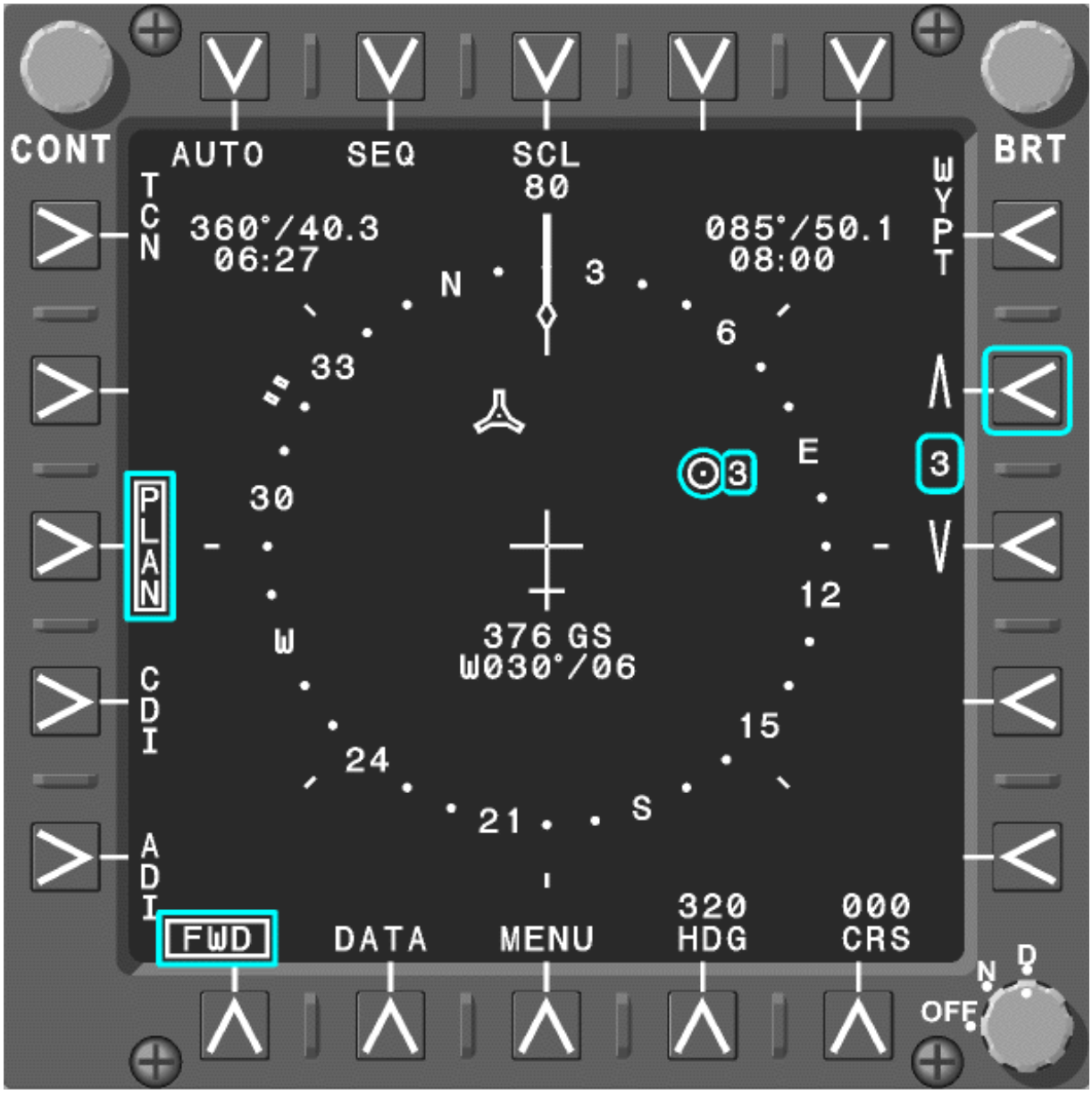


Figure 1: PLAN MODE WITH NO STEERING

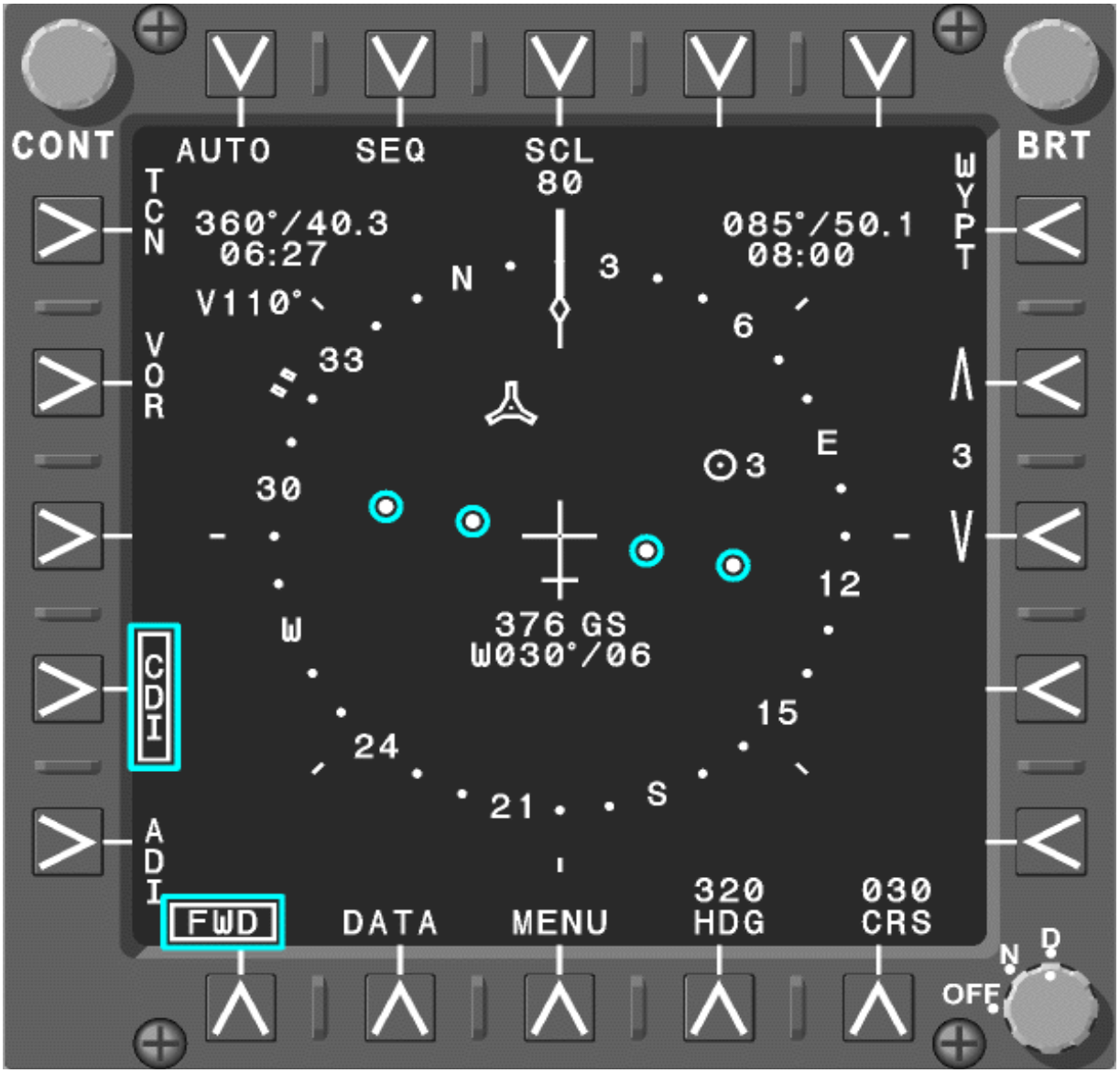


Figure 2: CDI MODE WITH NO STEERING

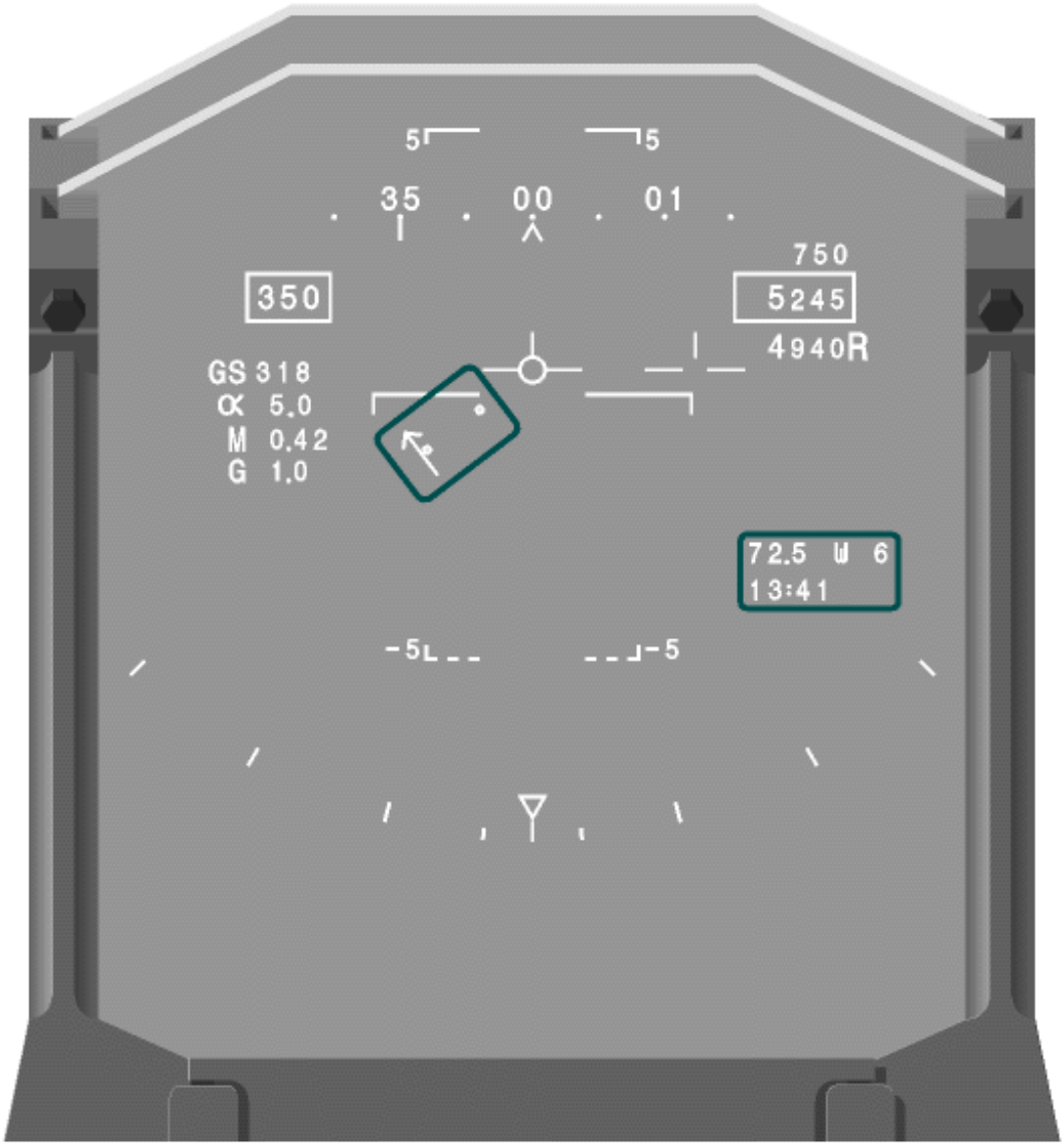


Figure 3: HUD VIEW WITH WAYPOINT STEERING

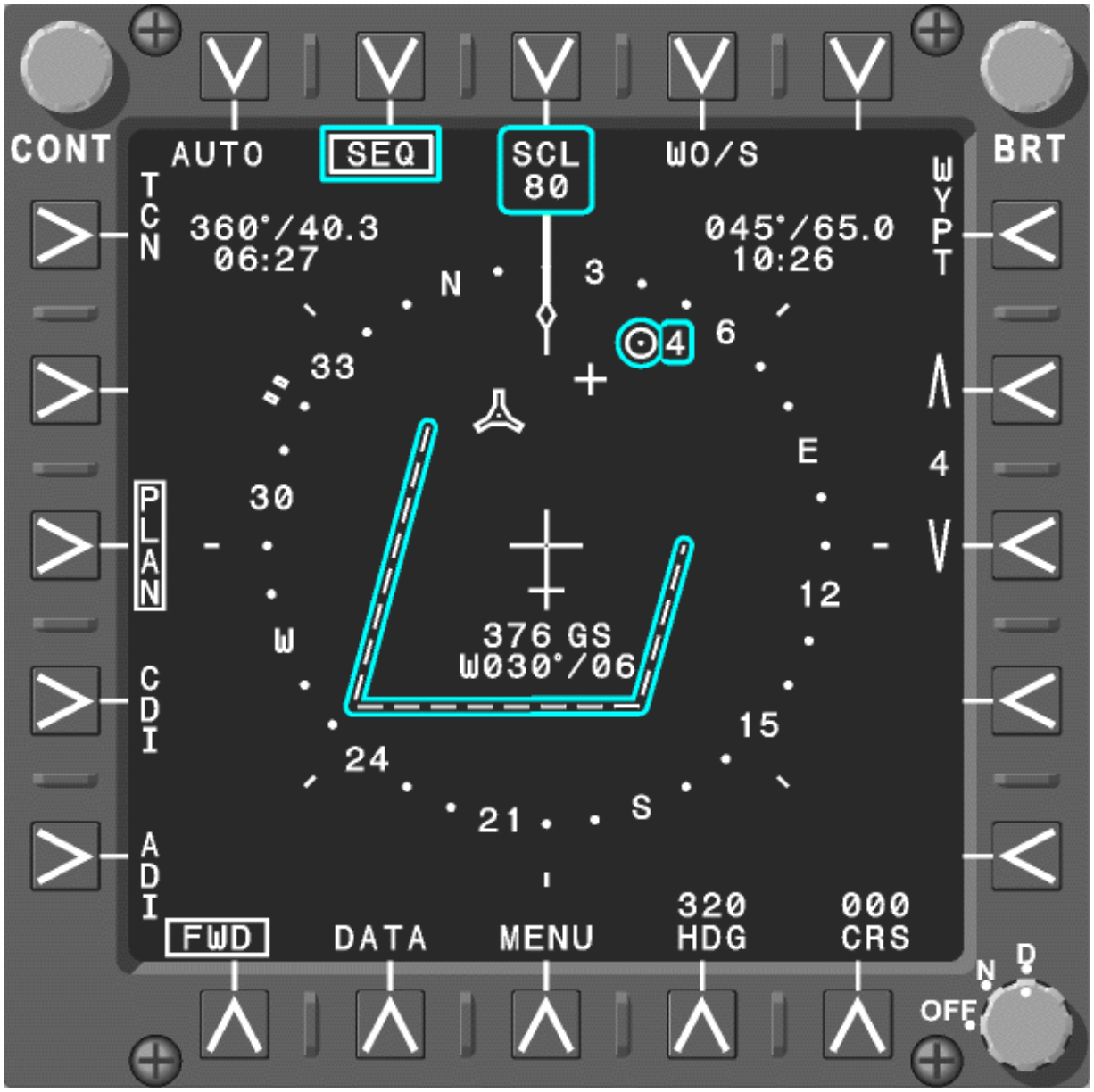


Figure 4: SEQ OPTION WITH NO STEERING - PLAN

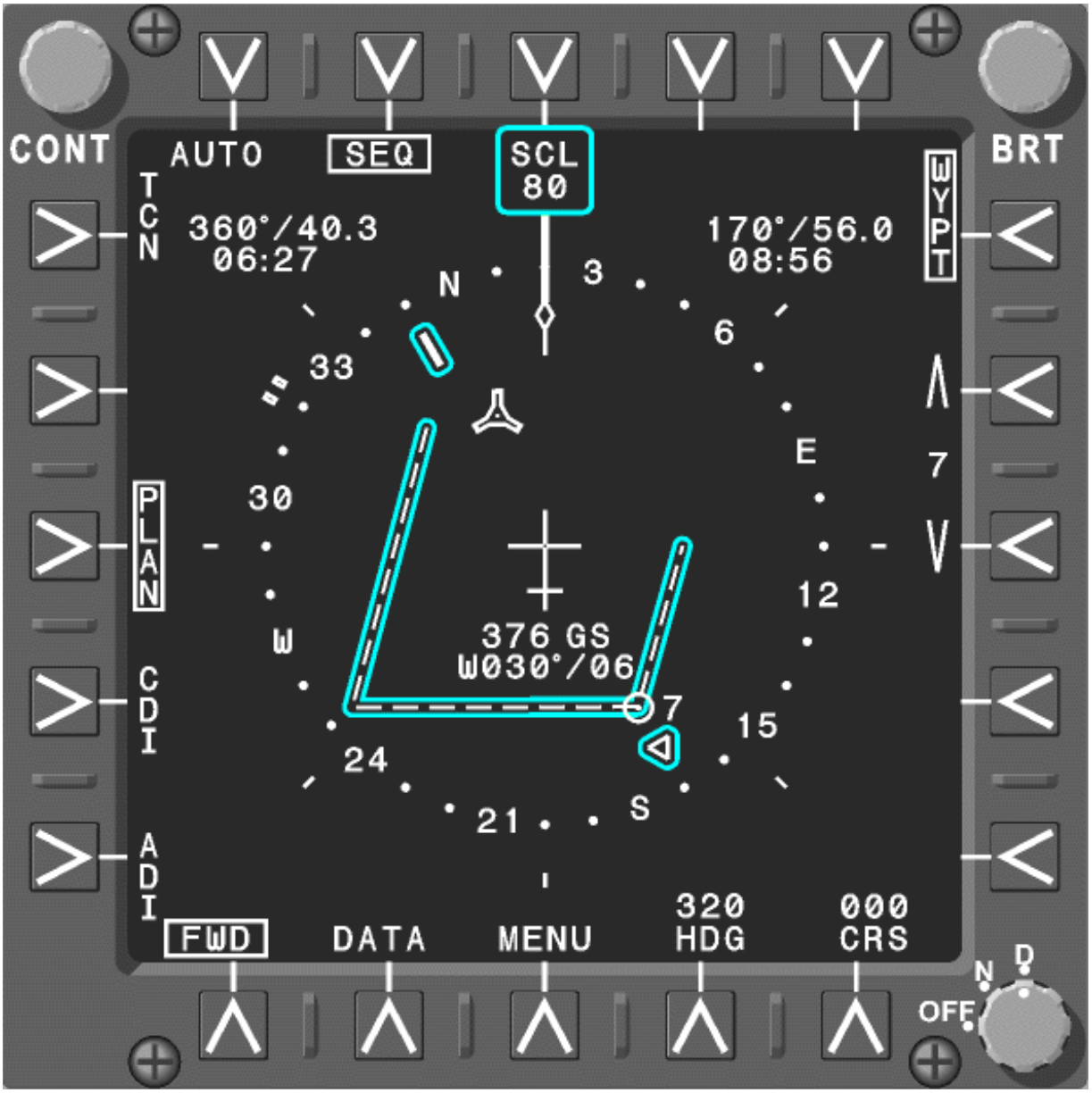


Figure 5: SEQ OPTION WITH WYPT STEERING - PLAN

Figure 6: SEQ OPTION WITH WYPT STEERING AND CRS - PLAN

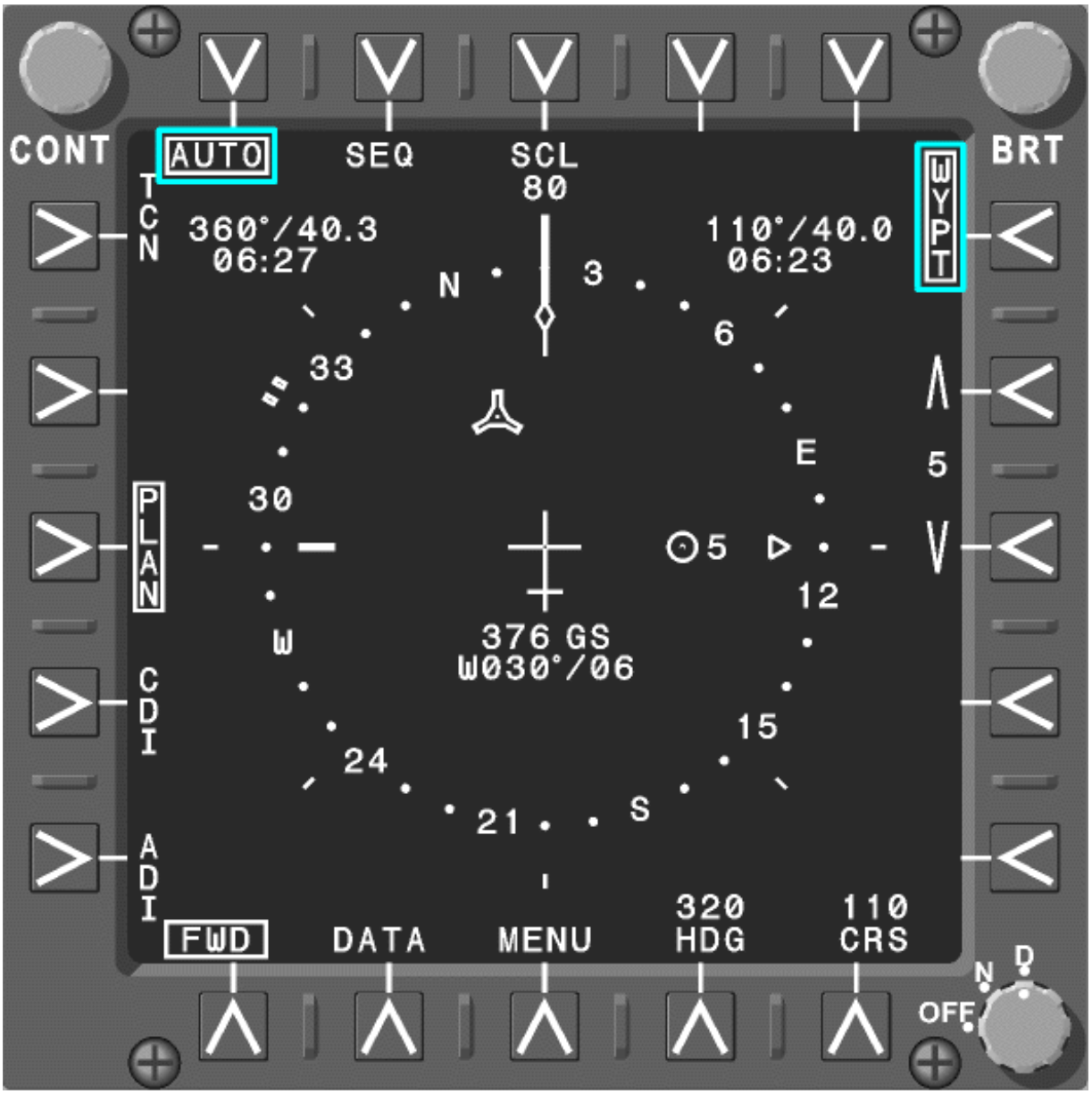


Figure 7: AUTO OPTION WITHOUT SEQ - PLAN

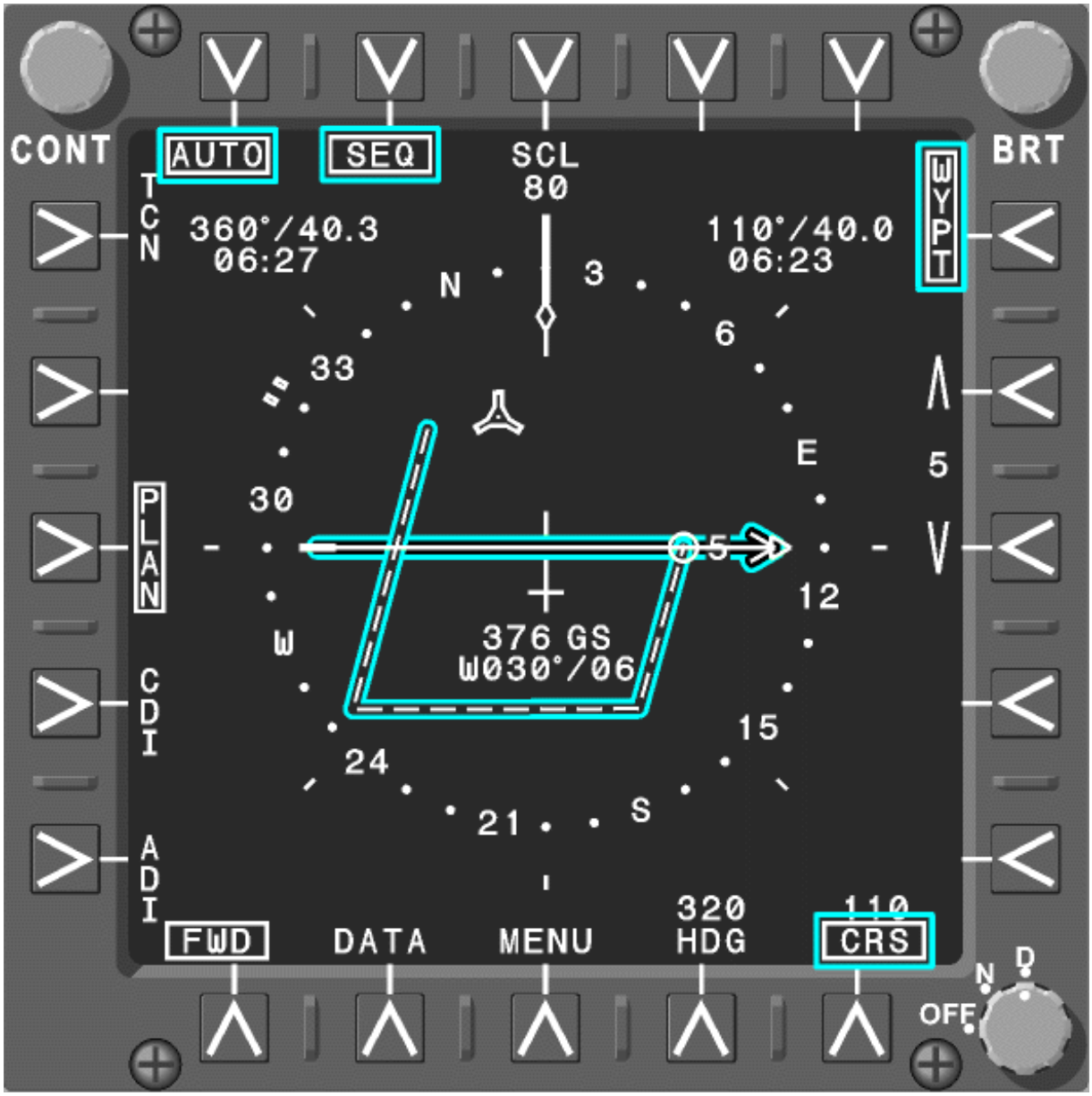


Figure 8: AUTO OPTION WITH SEQ AND CRS - PLAN

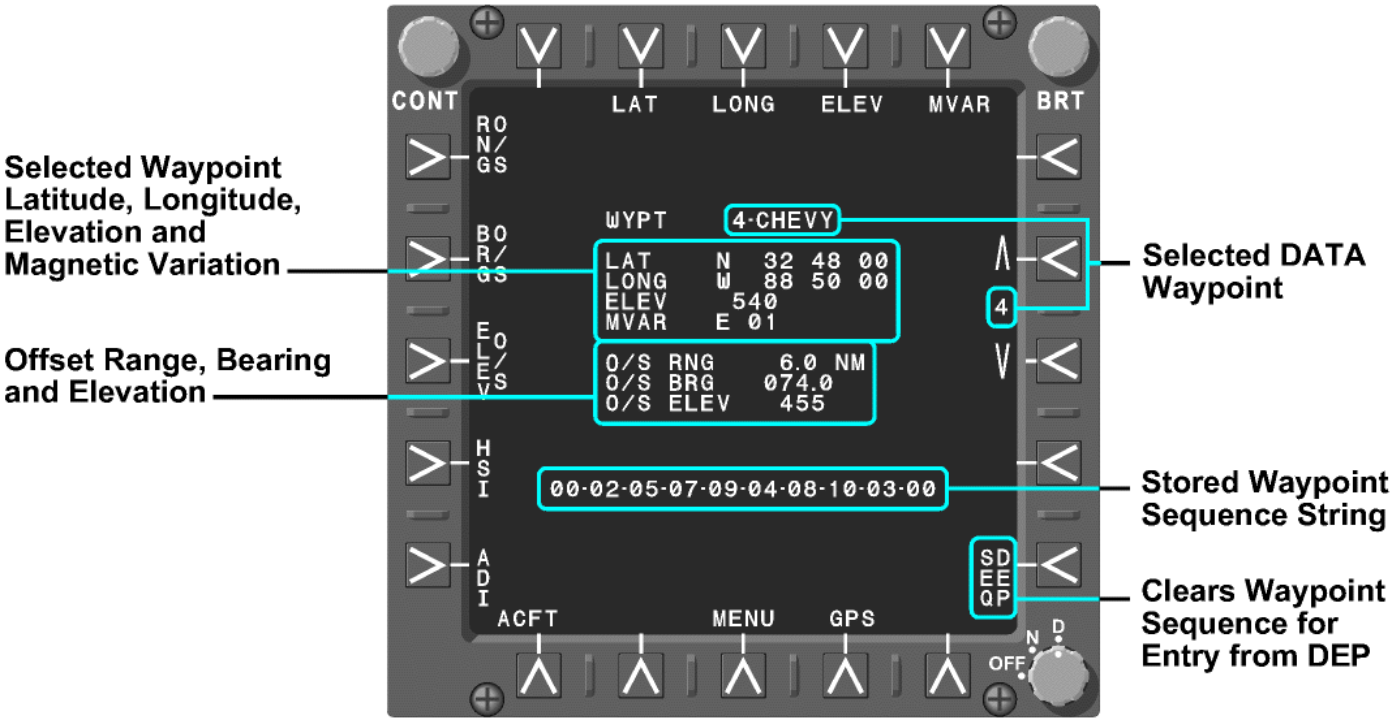


Figure 9: WAYPOINT DATA DISPLAY PAGE - 1

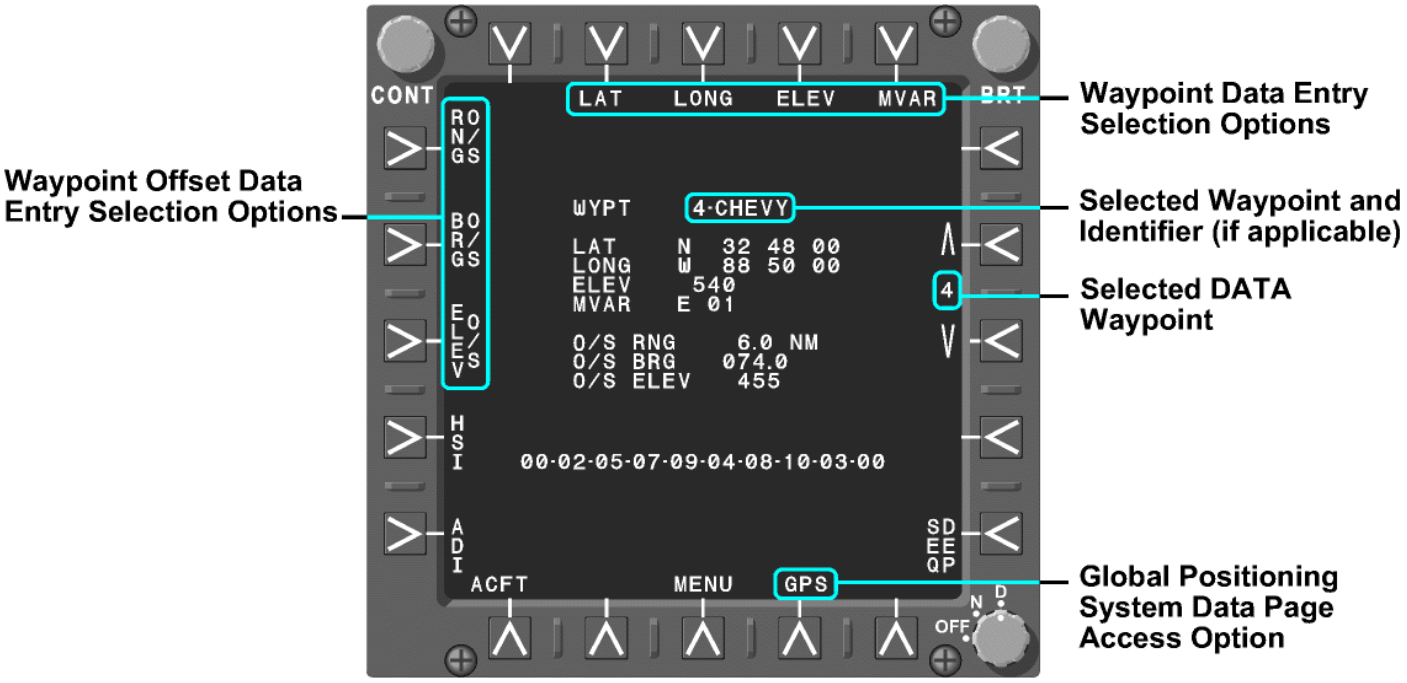


Figure 10: WAYPOINT DATA DISPLAY PAGE - 2

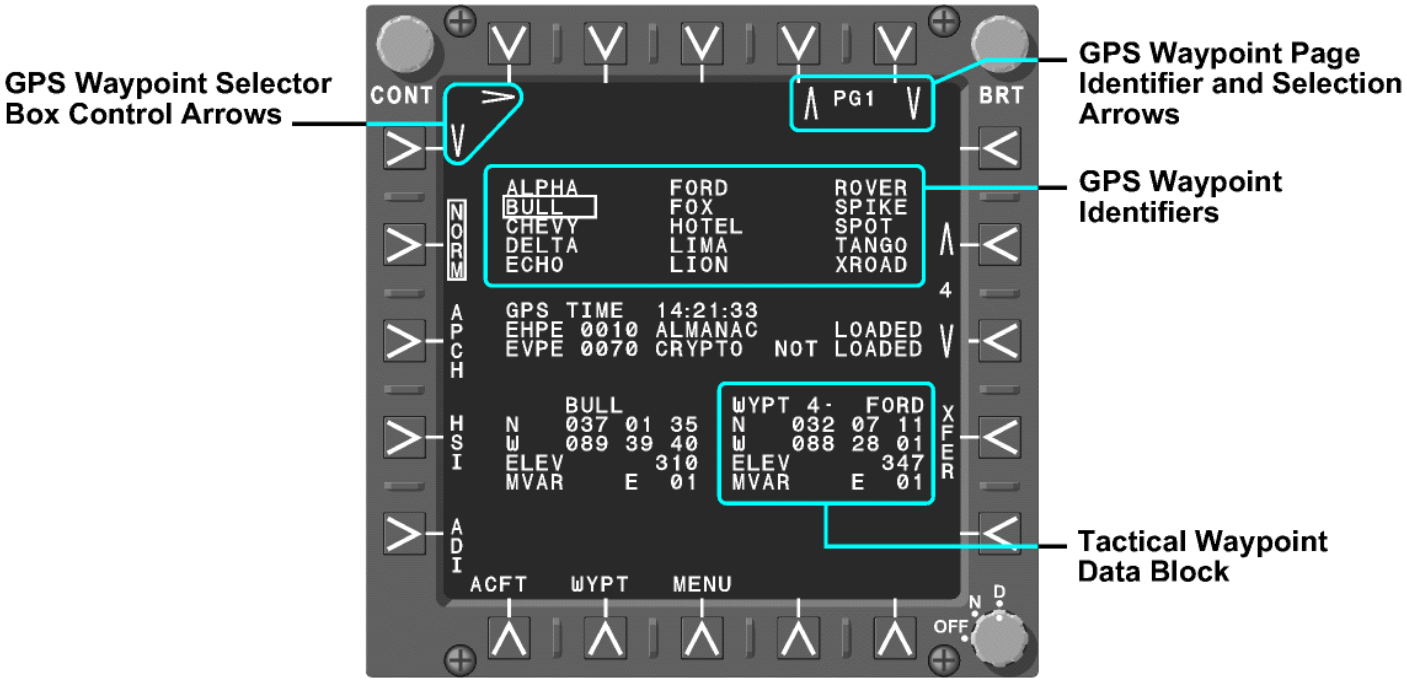


Figure 11: GPS DATA DISPLAY PAGE - 1

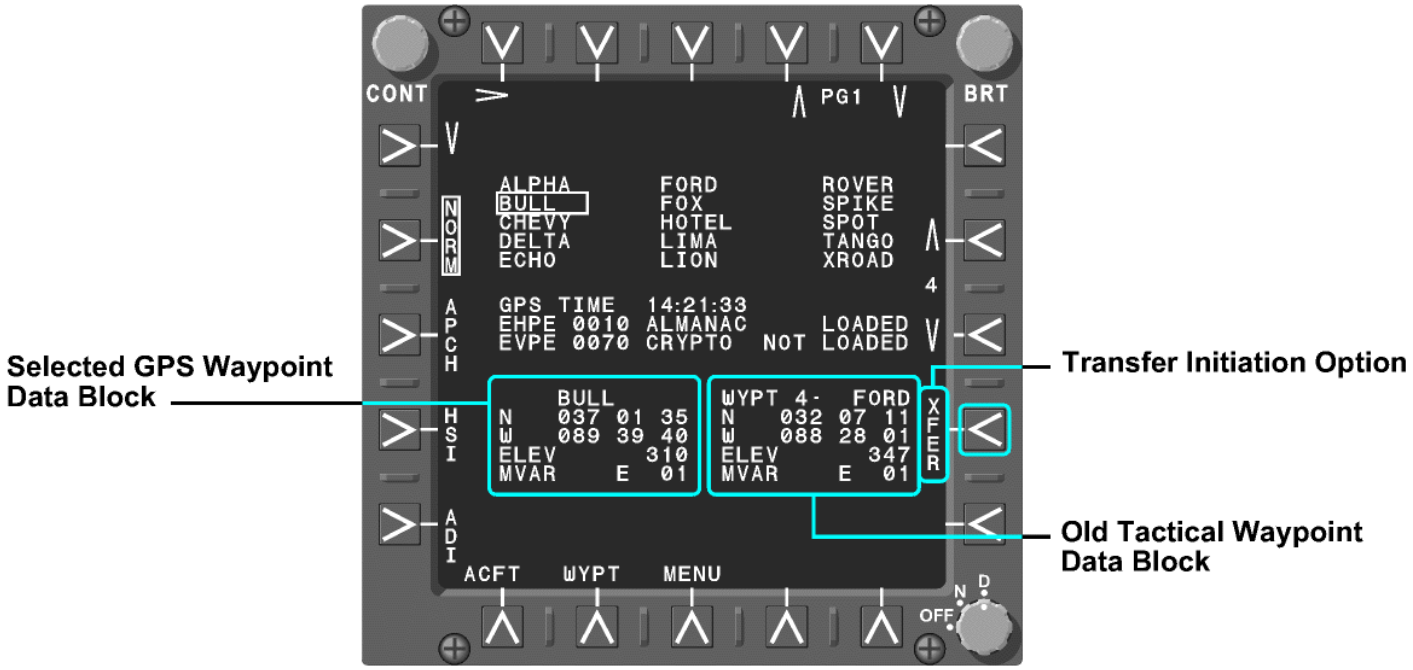


Figure 12: GPS DATA DISPLAY PAGE - 2

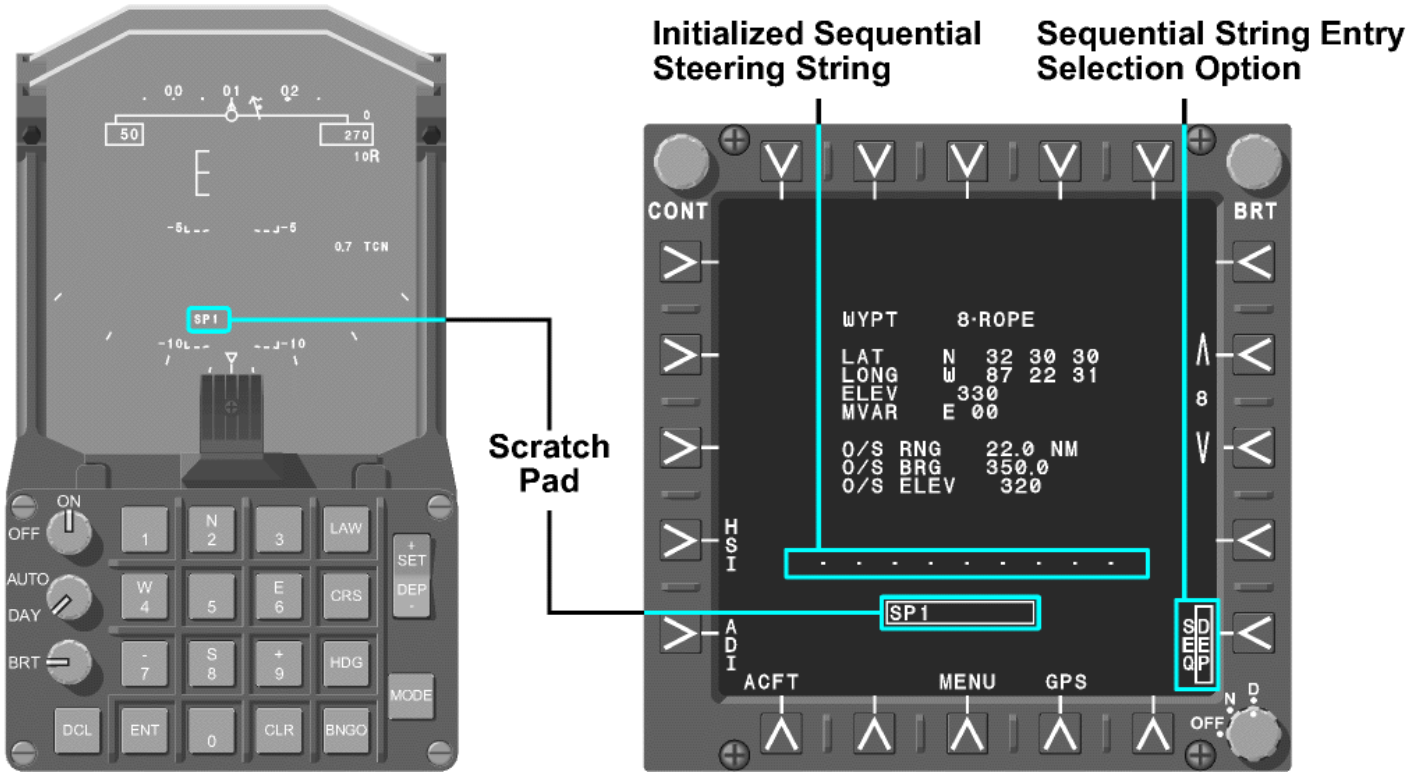


Figure 13: WAYPOINT STRING ENTRY USING DEP

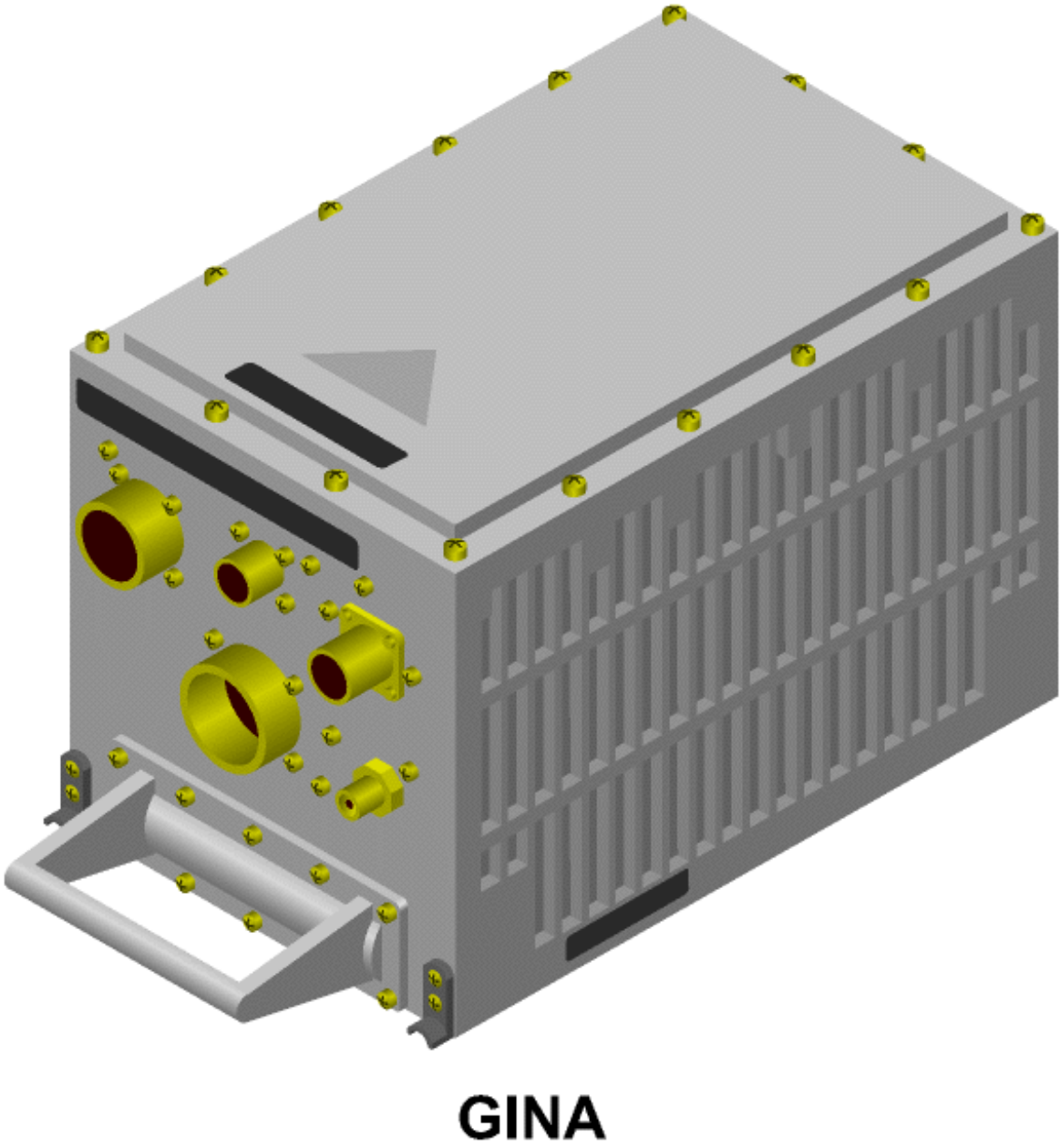
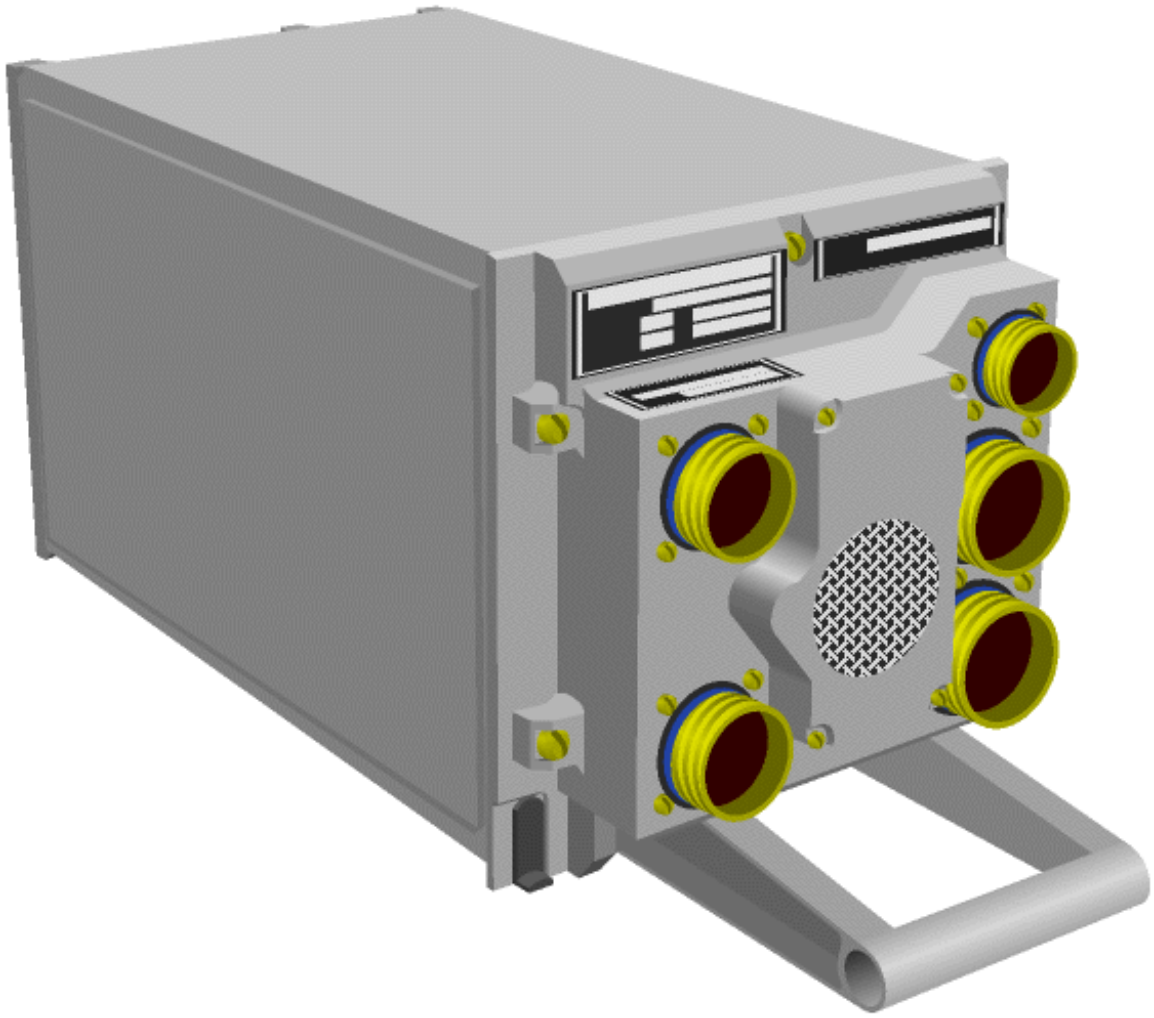


Figure 14: GLOBAL POSITIONING SYSTEM/INERTIAL NAVIGATION ASSEMBLY (GINA)



DEU

Figure 15: DISPLAY ELECTRONICS UNIT (DEU)

LECTURE GUIDE

COURSE/STAGE: TS, ADV, & IUT / Cockpit Orientation

LESSON TITLE: Ejection Seat Lecture

LESSON IDENTIFIER: T-45C TS, ADV, & IUT CO-06

LEARNING ENVIRONMENT: Classroom

ALLOTTED LESSON TIME: 1.0 hr

STUDY RESOURCES:

* T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

LESSON PREPARATION:

Read:

* NATOPS Chapter 2.16, "Ejection Seat System", in the T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

EXAMINATION:

The objectives in this lesson will be tested in the flight simulator and aircraft.

(10-99) ORIGINAL

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LECTURE GUIDE

COURSE/STAGE: TS, ADV, & IUT / Cockpit Orientation

LESSON TITLE: Velocity Vector

LESSON IDENTIFIER: T-45C TS & ADV CO-09
T-45C IUT CO-05

LEARNING ENVIRONMENT: Classroom

ALLOTTED LESSON TIME: 1.0 hr

STUDY RESOURCES:

* T-45C NATOPS Flight Manual, A1-T45AC-NFM-000

LESSON PREPARATION:

Review:
* NATOPS Chapter 2, Avionics Systems, Cockpit Controls and Displays

EXAMINATION:

The objectives in this lesson will be tested in the flight simulator and aircraft.

(10-99) ORIGINAL

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LESSON OBJECTIVES

1.9.3.1.5
Recall relationship of the HUD velocity vector symbology to aircraft flight path

1.9.3.1.5.1
Recall procedures/techniques for utilizing HUD velocity vector symbology VMC

1.9.3.1.5.2
Recall procedures/techniques for utilizing HUD velocity vector symbology IMC

MOTIVATION

Your T-45C HUD system and its velocity vector convey aircraft movement information not otherwise clearly available to you, the pilot. It details exactly where your aircraft is going with relationship to the ground and airborne objects in view. It enhances your ability to precisely control and position your aircraft, which results in safer tactical weapons delivery, approaches for landing, inflight rejoins, situational awareness, plus overall navigation and control.

The HUD velocity vector (sometimes titled with another name depending upon the manufacturer) is an integral part of modern HUD systems. Learn to use your T-45C HUD and velocity vector well, for they will help you to become an even safer and more capable pilot.

OVERVIEW

This lesson will introduce you to the HUD velocity vector system in preparation for your first flight in the T-45C. The lesson presents the velocity vector topic areas listed below.

* Aircraft movement versus heading
* Velocity vector relationship to aircraft waterline
* Display limits
* Uncaged and Caged
* HUD modes
* Pilot techniques

PRESENTATION

I. Aircraft movement versus heading **1.9.3.1.5**

A. The HUD displays a velocity vector, which depicts the aircraft's actual direction of movement

B. The ADI displays aircraft pitch and bank angles

Sg 1, fr 1

HUD VELOCITY VECTOR PROCEDURES

* **Aircraft Movement Versus Heading**
* Velocity Vector Relationship to Aircraft Waterline
* Display Limits
* Uncaged and Caged
* HUD Modes
* Pilot Techniques

Sg 1, fr 2

VELOCITY VECTOR SHOWS AIRCRAFT MOVEMENT VECTOR

Sg 1, fr 2A: *Video*

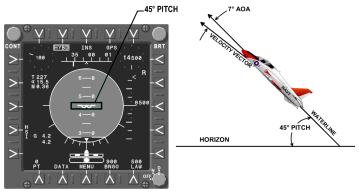
TAKEOFF

Sg 2, fr 1

HUD VELOCITY VECTOR PROCEDURES

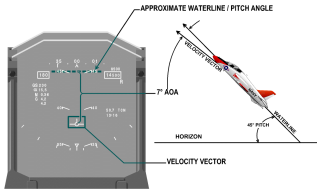
* Aircraft Movement Versus Heading
* **Velocity Vector Relationship to Aircraft Waterline**
* Display Limits
* Uncaged and Caged
* HUD Modes
* Pilot Techniques

Sg 2, fr 2



ADI PITCH vs VELOCITY VECTOR

Sg 2, fr 2A



HUD PITCH vs VELOCITY VECTOR

II. Velocity vector relationship to aircraft waterline **1.9.3.1.5**

A. Waterline is the point from which aircraft pitch and velocity vector angles are measured (both HUD and ADI)

NOTE: Following GINA alignment the HUD's waterline symbol (same as on the ADI) is replaced by the velocity vector symbol, which orients by different rules.

B. The waterline on the HUD falls along an imaginary line connecting the tops of the KIAS and barometric altitude digital data boxes

C. The number of degrees on the pitch ladder between the velocity vector and the waterline equals True AOA in degrees (not units)

NOTE: Estimating True AOA in degrees using the HUD's pitch ladder and waterline reference is simple and clear-cut, when the pitch ladder is upright, even when the velocity vector is significantly deflected for drift and/or side-slip. However, when the pitch ladder has rotated for bank (e.g., 90 degrees) and the velocity vector is significantly deflected left or right of the pitch ladder center line due to slip or drift, visually estimating True AOA is no longer possible.

D. Another way (always available) to determine True $AOA^{(DEGREES)}$ is arithmetic:

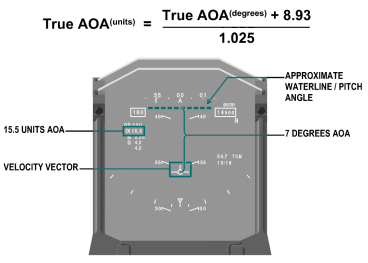
LESSON NOTES

To avoid potential misunderstandings, it is important that students clearly comprehend the distinction between AOA in degrees and AOA in units. Both are used in T-45C NATOPS general discussions and in conjunction with performance data computations.

1. HUD digital AOA values are displayed in units
2. HUD graphic depiction of the velocity vector is in degrees on the pitch ladder
3. AOA degrees and units are not equal values
4. T-45C difference between velocity vector digital (units) and HUD velocity vector (degrees) is a constant factor, as per the following formula

$$\text{True AOA}^{(\text{UNITS})} = \frac{\text{True AOA}^{(\text{DEGREES})} + 8.93}{1.025}$$

Sg 2, fr 3



AOA DEGREES AND UNITS

LESSON NOTES

When zero is entered in the above formula for True AOA (DEGREES), the HUD (UNITS) figure computes to be +8.7 (UNITS). At 30 True AOA(DEGREES) the result is +38.0(UNITS). So, for practical purposes it can be said that the digital AOA in units is always approximately +8.0-8.7 units more than true AOA in degrees.

Sg 3, fr 1

HUD VELOCITY VECTOR PROCEDURES

* Aircraft Movement Versus Heading
* Velocity Vector Relationship to Aircraft Waterline
* **Display Limits**
* Uncaged and Caged
* HUD Modes
* Pilot Techniques

Sg 3, fr 1A

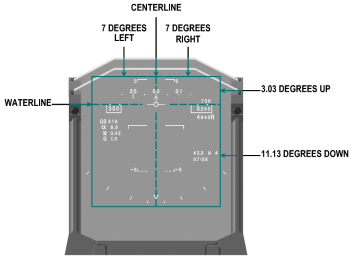
The Following HUD Video Show:

* Aerobatic loop
* NAV mode
* Cruise sub-mode
* Unlimited and limited velocity vectors
* Caged and ghost (partial) velocity vectors

Sg 3, fr 1B: *Video 2*

LOOP

Sg 3, fr 2



VELOCITY VECTOR DISPLAY LIMITS

III. Display limits **1.9.3.1.5**

A. Unlimited velocity vector movement

1. Definition of UNLIMITED: When the velocity vector is displayed at some point within the HUD display limits; not flashing at the edge

2. Vertical (from the waterline): 11.13 positive (+) AOA degrees

3. Vertical (from the waterline): 3.03 negative (-) AOA degrees

4. Azimuth (from HUD centerline): 7 degrees left/right

LESSON NOTES

The vertical and horizontal velocity vector display limits form a rectangular box overlaying the HUD. The 7 degrees left/right azimuth figures stated above presume a pitch ladder that is centered: no drift or side-slip. If in fact drift and/or side-slip are present, the pitch ladder centerline will no longer be congruent with the HUD centerline. Then, the maximum possible degrees left/right vertical velocity displacement prior to becoming "limited" will be unequal; however, total left/right deflection will remain 14 degrees.

B. Limited velocity vector

1. Definition of LIMITED: When the velocity vector plot falls outside the HUD velocity vector display limits

2. Characteristics

a. Velocity vector is positioned on the velocity vector display limit periphery

b. Velocity vector flashes at a 3.125 Hz rate

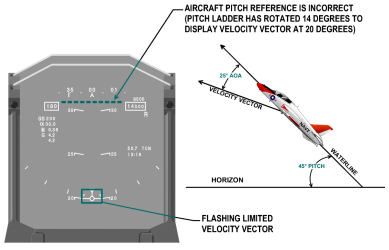
NOTE: A flashing velocity vector indicates that the HUD climb/dive pitch reference at the waterline may have become invalid because of HUD pitch ladder rotation around the velocity vector. Also, it alerts the pilot that his HUD velocity vector position is no longer accurately positioned with respect to objects outside the cockpit viewed through the HUD.

c. HUD Pitch ladder rotates, as required depending upon degrees of AOA, around a vertically limited velocity vector

Sg 3, fr 3

VERTICALLY LIMITED VELOCITY VECTOR

Sg 3, fr 4



ROTATED PITCH LADDER

LESSON NOTES

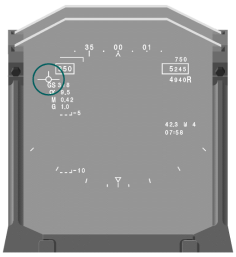
When the velocity vector is limited due to a high positive (or low negative) AOA, the HUD pitch ladder will rotate, as required, to accurately display the True velocity vector's position on the pitch ladder.

Consider the following example: Pitch angle is zero; aircraft nose is on the horizon. True AOA is +25 degrees; the HUD digital readout is approximately 33 (units). The velocity vector is at the bottom of the HUD and is flashing to indicate it is limited.

The pitch ladder is rotated in order to show the velocity vector at minus 25 degrees descent angle, which correlates with True AOA (+25 degrees) and zero pitch attitude. Pitch ladder rotation is necessary to display True AOA at minus 25 degrees, since the 11.13 degree HUD vertical display limit is exceeded. That causes the climb/dive waterline pitch reading to become invalid. Instead of it indicating zero pitch attitude (the aircraft's actual pitch), the HUD waterline reference now indicates the aircraft nose to be pitched down 14 degrees, which is an incorrect pitch representation. Fourteen (14) degrees represents the amount of rotation required to display the limited velocity vector at its 25 degrees nose down position in the HUD field-of-view.

d. The velocity vector can also become laterally limited

Sg 3, fr 5



LATERALLY LIMITED VELOCITY VECTOR — NO PITCH LADDER ROTATION

e. Exact azimuth point at which the HUD pitch climb/dive reference becomes invalid due to rotation is ambiguous

Sg 3, fr 6

LIMITED VELOCITY VECTOR — POSSIBLE PITCH LADDER ROTATION

LESSON NOTES

With wings level when a limited velocity vector is displayed at the far left or right side of the HUD, versus at the bottom or top, HUD pitch-ladder rotation is not a factor, only lateral displacement of the velocity vector. However, at some point between the 90 to 180 and 180 to 270 degree azimuth positions, pitch ladder rotation commences. That exact azimuth point is ambiguous and dependent upon variable AOA, drift, and side-slip factors. As a general rule do not trust the HUD climb/dive pitch indications when the velocity vector is flashing (limited): CHECK THE ADI for aircraft pitch.

IV. Uncaged and Caged **1.9.3.1.5**

A. Uncaged option

1. DEFINED: The True velocity vector may displace anywhere within the velocity vector display limits for yaw/drift/AOA effects

a. Vertical (down): 11.13 degrees positive (+) AOA

b. Vertical (up): 3.03 degrees negative (-) AOA

c. Azimuth (left/right): 7 degrees drift and/or slip

Sg 4, fr 1

HUD VELOCITY VECTOR PROCEDURES

* Aircraft Movement Versus Heading
* Velocity Vector Relationship to Aircraft Waterline
* Display Limits
* **Uncaged and Caged**
* HUD Modes
* Pilot Techniques

Sg 4, fr 1A

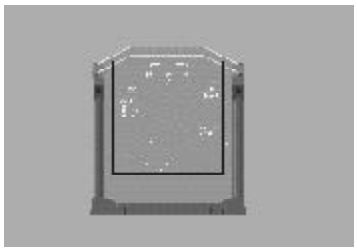
The Following HUD Video Show:

* Aerobatic split-s
* NAV mode
* Cruise sub-mode
* Unlimited and limited velocity vectors
* Caged and ghost velocity vectors

Sg 4, fr 1B: *Video 3*

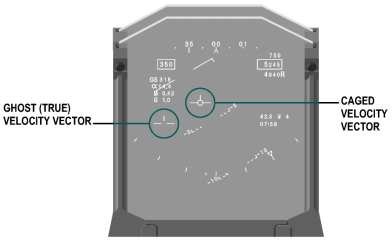
SPLIT-S

Sg 4, fr 2



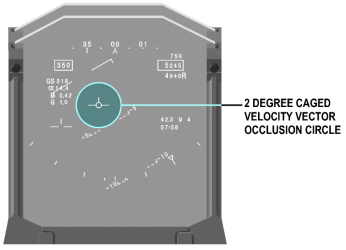
VELOCITY VECTOR DISPLAY AREA

Sg 4, fr 3



CAGED AND GHOST VELOCITY VECTORS

Sg 4, fr 4



CAGED VELOCITY VECTOR OCCULSION AREA

NOTE: Ghost velocity vector is <u>not</u> generated in uncaged option; only in caged option (discussed later in this lesson).

2. Limited (Uncaged) velocity vector characteristics

   a. Occurs when the True velocity vector position plot falls outside the velocity vector display limits

   b. Velocity vector flashes on velocity vector display perimeter at a point that indicates the approximate azimuth of the displaced true velocity vector plot

B. Caged option

1. DEFINED: Both Caged and Ghost (True) velocity vectors are generated for display and the Caged velocity vector maintains itself near the center of the HUD

2. Caged (solid) velocity vector is <u>always</u> visible (limited or unlimited)

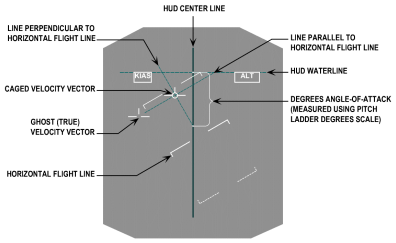
3. Caged velocity vector symbol is surrounded by a circular 2 degree (as measured on pitch ladder) occlusion zone that hides the Ghost (True) velocity vector symbol, when both are in close proximity, preventing them from over-writing each other in the display

4. Caged velocity vector is derived from the intersection of two lines

   a. LINE-1: Plotted <u>perpendicular</u> to the pitch ladder's Horizontal Flight Lines, originating from a point on the HUD centerline that equals the degrees of AOA (True) degrees measured from the invisible HUD waterline reference

   b. LINE-2: Plotted <u>parallel</u> to the pitch ladder's Horizontal Flight Lines from the Ghost (True) velocity vector plot point

Sg 4, fr 5



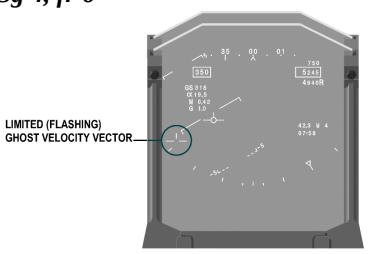
POSITIONING GHOST VELOCITY VECTORS

LESSON NOTES

Only the Ghost/True velocity vector (unlimited) can be referenced to <u>correctly</u> observe <u>actual</u> aircraft movement in relationship to terrain and objects seen through the HUD. The Caged velocity vector is artificially (arithmetically) repositioned to keep it oriented near the center of the HUD display, and to make that vector less likely to become limited. But, once again, the Caged velocity vector does <u>not</u> indicate <u>actual</u> aircraft vector movements in relationship to terrain and objects viewed through the HUD.

5. When the Ghost (True) velocity vector becomes periphery limited it flashes at 3.125 Hz

Sg 4, fr 6



CAGED AND GHOST (LIMITED) VELOCITY VECTORS

NOTE: It may become limited but not be visible because it is behind the Caged velocity vector's 2 degree occulsion zone.

6. It is possible -- remotely -- for both the Ghost (True) and Caged velocity vectors to be visible and simultaneously limited; then, both will flash on the perimeter of the velocity vector display limit

C. Cage/Uncage controls

1. Select main MENU on an MFD

   a. Select HUD sub-menu

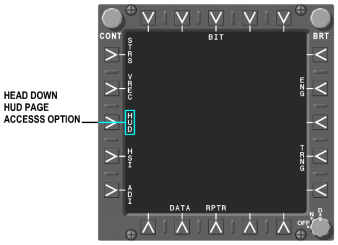
   b. Select CAGE to box or unbox the CAGE legend

      NOTE: Velocity vector is caged when CAGE is boxed; Uncaged when unboxed.

2. Press flight control stick grip Cage/Uncage button

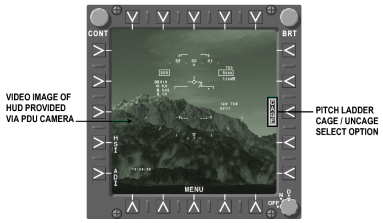
   NOTE: Changing the option from Caged to Uncaged using this button also causes appropriate boxing/unboxing of the CAGE legend on the MFD HUD display page.

Sg 4, fr 7



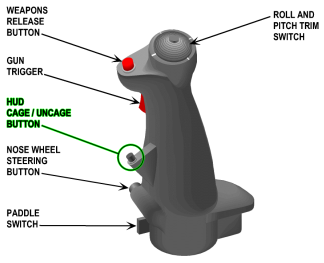
MAIN MFD MENU

Sg 4, fr 8



HUD MENU

Sg 4, fr 9



STICK GRIP

V. HUD modes **1.9.3.1.5.1, 1.9.3.1.5.2**

A. Navigation (NAV) mode

1. Approach (APCH) sub-mode

a. Velocity vector initializes to the Caged option; subsequently, the Uncaged option may be selected

b. Cruise sub-mode is automatically entered from APCH sub-mode when landing gear is raised

c. HUD initializes to APCH sub-mode at power-up with weight on the wheels

d. HUD display includes the AOA "E" bracket (16, 17, 18 units AOA)

e. AOA "E" bracket is always associated with the solid velocity vector

f. A limited (flashing) velocity vector cannot be displayed within the limited AOA "E" bracket (a display generation restriction); HUD digital AOA(UNITS) is displayed in that circumstance

g. Digital AOA is displayed whenever the velocity vector plots outside the AOA "E" bracket in Normal mode (neither Declutter-1 or Declutter-2 selected)

2. Cruise sub-mode

a. Velocity vector initializes to the Caged option; the Uncaged mode option can be selected

b. APCH sub-mode is automatically entered when landing gear is extended

c. There is no AOA "E" bracket display

Sg 5, fr 1

HUD VELOCITY VECTOR PROCEDURES

* Aircraft Movement Versus Heading
* Velocity Vector Relationship to Aircraft Waterline
* Display Limits
* Uncaged and Caged
* **HUD Modes**
* Pilot Techniques

Sg 5, fr 1A

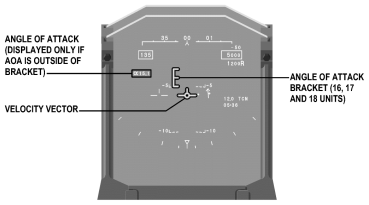
The Following HUD Video Show:

* Aerobatic barrel roll
* NAV mode
* Cruise sub-mode
* Unlimited and limited velocity vectors
* Caged and ghost velocity vectors

Sg 5, fr 1B: *Video 2*

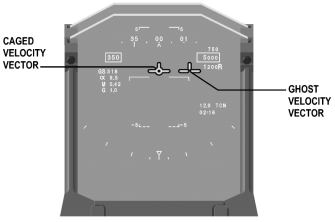
BARREL ROLL

Sg 5, fr 2



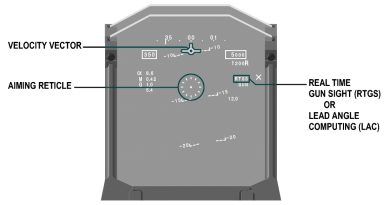
NAV APPROACH SUB-MODE (GEAR DOWN)

Sg 5, fr 3



NAV CRUISE SUB-MODE (GEAR UP)

Sg 5, fr 4



AIR-TO-AIR (RTGS) MODE

Sg 5, fr 4A

The Following HUD Video Show:

* Intercept gun attack
* A/A mode
* RTGS sub-mode
* Caged (unlimited) velocity vector
* Gun reticle trigger firing "X"

Sg 5, fr 4B: *Video 5*

AIR-TO-AIR/RTGS

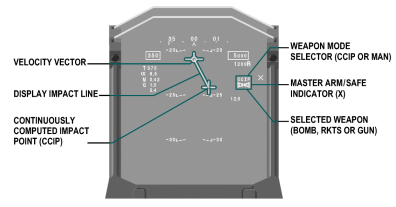
B. Air-to-air (A/A) mode

1. Velocity vector initializes to the Caged option
2. Available options (pilot choice)
   a. Caged
   b. Uncaged

LESSON NOTES

Extremely off-centered velocity vector displacement on the HUD, which is possible when using the Uncaged option, can be disorienting for a pilot during some air-to-air maneuvering. It can also cause inaccurate HUD pitch representations during large slip and drift conditions. For these reasons, Caged is the A/A default option. Remember, only the Ghost (True) velocity vector depicts actual aircraft movement with respect to terrain and other objects seen through the HUD.

Sg 5, fr 5



AIR-TO-GROUND (CCIP) MODE

C. Air-to-ground (A/G) mode

NOTE: The manual (MAN) video clip was flown with the MASTER ARM switch in SAFE position, indicated by the "X" super-imposed over BOMB.

1. Velocity vector initializes to the Uncaged option
2. Available options (pilot choice)
   a. Caged
   b. Uncaged

LESSON NOTES

In air-to-ground work the pilot is concerned with the aircraft's actual movement with respect to his target as depicted by the velocity vector (and aiming reticle devices). A Caged velocity vector presents an arithmetically adjusted velocity vector picture; hence, Uncaged is the default A/G option, for it gives a true picture as seen through the HUD, unless the velocity vector becomes limited.

Sg 5, fr 5A

The Following HUD Video Show:

* Ground attack
* A/G mode
* CCIP sub-mode
* Uncaged (unlimited) velocity vector
* Impact line
* Impact point
* Bomb release "X"

Sg 5, fr 5B: *Video 6*

AIR-TO-GROUND/CCIP

Sg 5, fr 5C

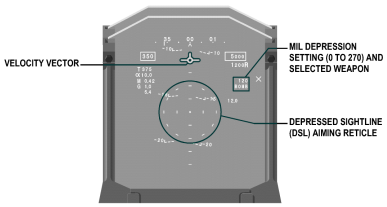
The Following HUD Video Show:

* Ground attack
* A/G mode
* MAN sub-mode
* Uncaged (unlimited) velocity vector
* Depressed sight line (DSL) aiming reticle
* No bomb release "X" (MASTER ARM was not switched ON)
* CAUTION advisory

Sg 5, fr 5D: *Video 7*

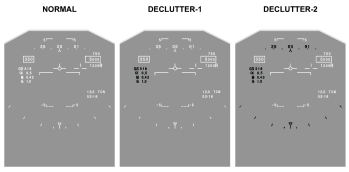
AIR-TO-GROUND/MAN

Sg 5, fr 6



AIR-TO-GROUND (MAN) MODE

Sg 5, fr 7



NAV-CRUISE DECLUTTER OPTIONS

D. Declutter options have no effect on the actual velocity vector display

LESSON NOTES

The NAV-Cruise declutter options are shown as an example that declutter has no effect on velocity vector display. The same is true for all declutter options for all other HUD modes.

Sg 6, fr 1

HUD VELOCITY VECTOR PROCEDURES

* Aircraft Movement Versus Heading
* Velocity Vector Relationship to Aircraft Waterline
* Display Limits
* Uncaged and Caged
* HUD Modes
* **Pilot Techniques**

VI. Pilot techniques **1.9.3.1.5.1, 1.9.3.1.5.2**

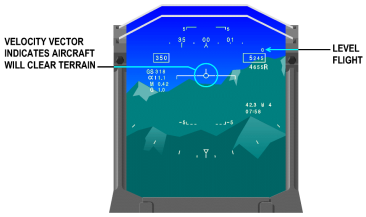
A. Use the velocity vector for an instantaneous picture of aircraft movement

B. Velocity vector is especially useful when flying low-level in mountainous terrain

NOTE: Velocity vector visually indicates impending terrain clearance or collision.

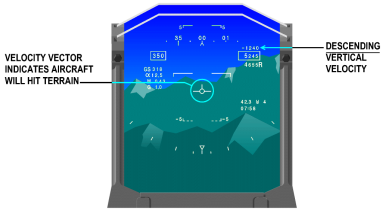
C. Use the velocity vector as a trend indicator (e.g., alerts pilot that a change in vertical velocity, airspeed, and altitude has occurred)

Sg 6, fr 2



INSTANTANEOUS PERFORMANCE PICTURE

Sg 6, fr 3



INSTANTANEOUS TREND INDICATOR

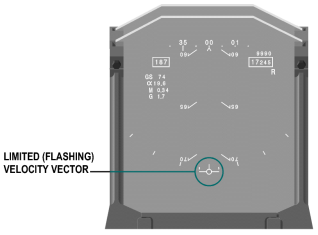
D. Use the FLASHING (limited) velocity vector symbol as a high-AOA alerting device during aggressive low-speed/high-AOA maneuvers, such as when going over-the-top during a loop. If (when) the velocity vector becomes limited and flashes at the bottom of the HUD, your AOA will at that precise moment be about 19.5(UNITS)

E. Maintain the velocity vector (unlimited Ghost/ True) exactly over a target, turnpoint, etc. when desiring to fly directly to that point

F. When entering base-turn from down-wind in the overhead landing pattern, a pilot can use the velocity vector to confirm initial descent has appropriately commenced

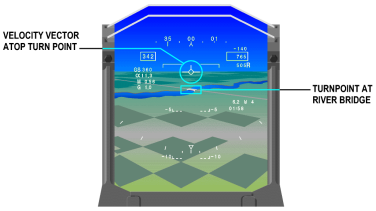
G. Monitor the velocity vector throughout the take-off and landing patterns as an additional flight safety tool; still fly the meatball and follow all LSO commands [when given]

Sa 6. fr 4



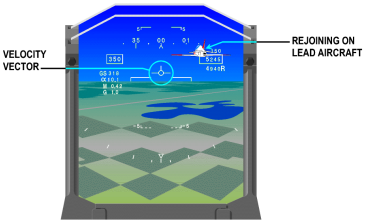
TOP OF A VERTICAL MANEUVER — HIGH AOA

Sg 6, fr 5



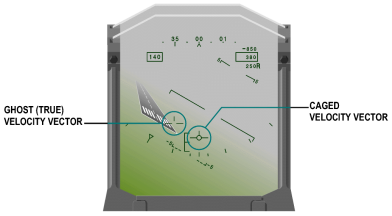
FLYING DIRECTLY TO A POINT

Sg 6, fr 6



SAFE SEPARATION DURING REJOINS/INTERCEPTS/MANEUVERS

Sg 6, fr 7



IMC TO VMC TRANSITIONS

Sg 6, fr 8

AVOID HUD FIXATION

H. Monitor the (Ghost/True) velocity vector when approaching other aircraft visible through the HUD to assure proper clearance, e.g., straight-ahead rejoins

I. Reference the velocity vector when transitioning on final approach from IMC to VMC, especially in absence of LSO and meatball-type systems, and at other critical flight transition phases

LESSON NOTES

It is extremely important for pilots to realize that a proper runway aimpoint for landing (indicated by velocity vector position) means very little, unless the approach glideslope is also correct (within a normal parameter). Appropriate aircraft flight control and power inputs must be made to correlate vertical velocity (glideslope) with approach aimpoint (velocity vector). With a very low ceiling and limited visibility, that correlation must be rapidly accomplished and performed using composite (visual and instrument) techniques. These pilot skills must be developed in addition to landing with the aid of a Fresnel optical landing system.

J. Avoid becoming a “HUD Cripple”

1. Do not become visually fixated on the HUD

2. Do not neglect cross-checking other cockpit instruments and indicators

3. Do not neglect visually clearing the sky for other aircraft when flying VMC, either IFR or VFR

SUMMARY

This lesson has discussed the following T-45C HUD velocity vector topic areas.

* Aircraft movement versus heading
* Velocity vector relationship to aircraft waterline
* Display limits
* Uncaged and caged
* HUD modes
* Pilot techniques

CONCLUSION

You now have a comprehensive understanding of the T-45C velocity vector system, including applicable HUD symbols, modes, and options. You understand that the velocity vector depicts actual aircraft movement, versus aircraft heading. You understand how HUD positioning of the various velocity vector types (True, Ghost, Caged, Limited, Unlimited) are determined. Finally, you understand various pilot procedures and techniques for using the velocity vector to enhance aircraft control and safety during IMC and VMC weather conditions.

Sg 7, fr 1

HUD VELOCITY VECTOR REVIEW OPTIONS

1. Entire lesson
2. Aircraft movement versus heading
3. Velocity vector relationship to aircraft waterline
4. Display limits
5. Uncaged and caged
6. HUD modes
7. Pilot techniques
8. End this lesson

Please select

NOTES