CHAPTER 12: SHORE BASED PROCEDURES

12.1 INTRODUCTION

This chapter will cover all the basics of takeoffs, landings and standard handling, including the systems most commonly used therein or description of which does not fit in other parts of this manual.

It will first cover items like radar altimeter, Low Altitude Warning System, Ground Proximity Warning System and all functions of the VREST page (used both for takeoffs / landings and during the flight to calculate maximum range and cruising altitude).

It is important to bear in mind that the AV-8B Harrier is a very special airplane, which allows for a number of different takeoffs, depending on current situation, load out, weather, available runway (or lack of one) etc. Most of them require a number of steps and checks that need to be completed, so it is best to describe them in the beginning before going into specific checklists.

12.2.1 RADAR ALTIMETER / LOW ALTITUDE WARNING

Radar Altimeter is an important instrument used during all types of takeoffs and landings, as it provides more accurate altitude data than the barometric altimeter.

1. ALT function selection pushbutton. When pressed, it brings up the Radar Altimeter information on the scratchpad and on the ODU.

2. Radar Altimeter status. Shows current status of the Radar Altimeter: ON if radar altimeter is enabled and blank space if it is off. In order to switch between both modes a ON-OFF pushbutton on the UFC is used.

3. LAW Threshold Altitude. Displays currently selected Law Altitude Warning system altitude (in feet). Please see below for more information.

4. Radar Altimeter ODU Options. Whenever ALT pushbutton is pressed, it brings up four additional options on the ODU.

1. GPWS (Ground Proximity Warning System). GPWS is a safety backup system that alerts the aircrew of an impending controlled flight into terrain (CFIT) condition. When colonised, the GPWS system is enabled. Deactivation (removal of the colon) starts a 20-minute timer, after which system is automatically re-activated. Please see the **Ground Proximity Warning System** section for more information.

2. BOMB. With the ALT function selector switch pressed, BOMB is displayed in the option number 1 display window. With the radar altimeter operating, pressing the option number 1 pushbutton causes a colon to be displayed to the left of BOMB. The colon indicates that radar altitude is being used by the mission computer for ballistic computations.

3. PUC (Pull-Up Cue). When enabled, it provides cueing to the pilot to pull out of a dive to avoid flying into a weapon's fragmentation envelope or to release a weapon by a given altitude to ensure there is sufficient arming time prior to impact.

4. GPS. disables the Radar Altimeter and enables the GPS as the source for elevation data for weapon delivery in a GCIP delivery mode.

12.2.2 GROUND PROXIMITY WARNING SYSTEM

GPWS is a safety backup system that alerts the aircrew of an impending controlled flight into terrain (CFIT) condition. GPWS provides warnings of potentially unsafe maneuvering flight conditions, such as:

- excessive bank angles,
- excessive sink rates,
- gear-up landings,
- floor altitude violations,
- limited protection against flight into rising terrain,
- diving flight depending on flight stages that include takeoff, cruise, or landing
- Altitude Loss During Recovery (ALDR).

The GPWS is a look-down system with no forward look capability. GPWS uses the radar altimeter as the primary altitude source with ADC and INS as backup altitude sources when the radar altitude is invalid. GPWS calculates terrain slope with inputs from the INS and radar altimeter.

All GPWS warnings should be treated as imminent flight into terrain, unless reassessed situational awareness dictates otherwise.

GPWS warning cues

PWS provides unambiguous directive aural and visual cues to the aircrew for each potential CFIT condition. A HUD recovery cue, findicating the correct direction to recover the aircraft, and voice warnings are provided. GPWS voice warnings are:

- ROLL OUT (for excessive bank angle condition)
- CHECK GEAR (for potential gear-up landing condition)
- PULL UP (for flying below the floor altitude or Altitude Loss During Recovery)
- POWER (for excessive takeoff and landing sink rate).

Hud recovery cue examples

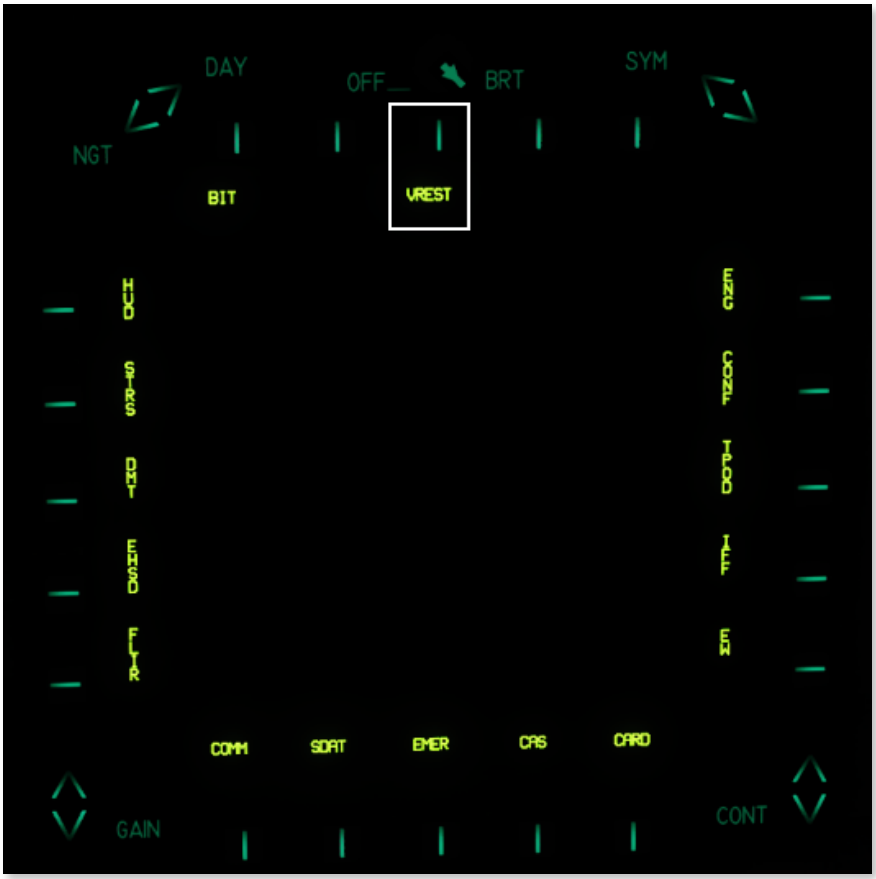
12.2.3 LOW ALTITUDE WARNING SYSTEM

The Low Altitude Warning system is a Radar Altimeter function that allows the pilot to set a specific altitude between 0 and 5000 feet. As long as it is operational and whenever the aircraft descends below this preset low altitude threshold, a Low Altitude Warning (LAW) light on the Master Warning Lights panel will turn on, accompanied by an ALTITUDE, ALTITUDE voice warning provided in conjunction with the LAW light.

Low Threshold Altitude is displayed on the scratchpad and set using the keyboard on the UFC, followed by ENT button. Radar Altimeter has to be set to ON for LAW to work.

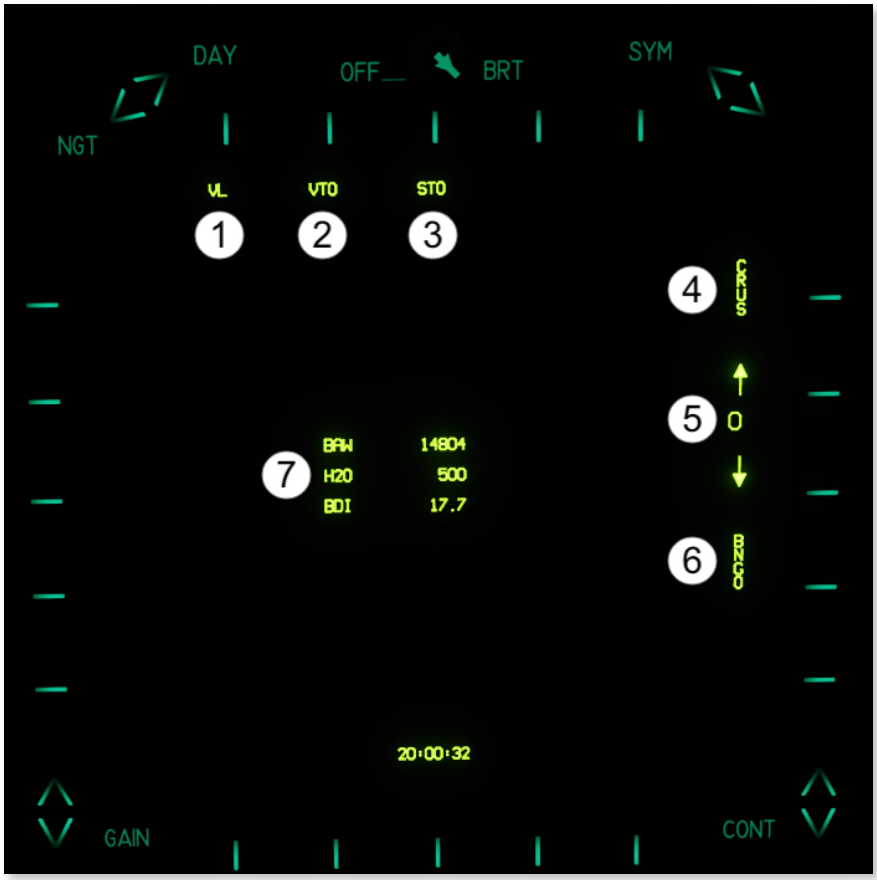
12.2.4 VREST

VREST (short for VSTOL, range, endurance, speed, and time) is the special function of the mission computer, which performs necessary calculations required for different types of takeoffs, cruise and bingo information and many more. VREST page is available in NAV and VSTOL master modes. In order to bring it up, press OSB 8 marked VREST on the main MPCD page.



There are five VREST displays: vertical landing (VL), vertical takeoff (VTO), short takeoff (STO), cruise (CRUS), and bingo (BNGO). To enable the desired display select the appropriate pushbutton VL, VTO, STO, CRUS or BNGO. Selection is indicated by the box around the legend.

BASIC DISPLAY



After selecting VREST, you enter the basic display, allowing you to choose between different, more specific options and providing the pilot with some basic data. These are:

1. VL (Vertical Landing Display): pressing this pushbutton (VL) selects vertical takeoff / landing display and causes VL and VTO to be boxed, indicating selection.

2. VTO (Vertical Takeoff Display): pressing this pushbutton (VTO) selects vertical takeoff / landing display and causes VTO and VL to be boxed, indicating selection.

3. STO (Short Takeoff Display): pressing this pushbutton (VL) selects short takeoff display and causes STO to be boxed, indicating selection.

4. CRU (Cruise display): pressing this pushbutton (CRU) selects Cruise display and causes CRU to be boxed, indicating selection.

5. Selected waypoint. The number between the arrows indicates selected waypoint. Waypoint can be changed by pressing the increment (OSB 11) or decrement (OSB 13) pushbutton. Changing waypoint does not change waypoint selection on EHSI/EHSD display. Pressing the increment or decrement pushbutton for more than 0.8 seconds enables a quick access session allowing the pilot to select between all 60 waypoints, 30 markpoints, and 1 targetpoint.

7. Basic Information. These consist of:

BAW (Basic Aircraft Weight): Shows the current aircraft weight in pounds (lbs), calculated constantly against the fuel use.

H2O (Water weight): shows the water weight in pounds (lbs).

BDI (Basic Drag Index): shows current aircraft drag index, based on current configuration. This info is used in all the VREST computations. It can also by introduced manually by the pilot ((see Drag Index Values table for computations).

BASIC DISPLAY ODU OPTIONS

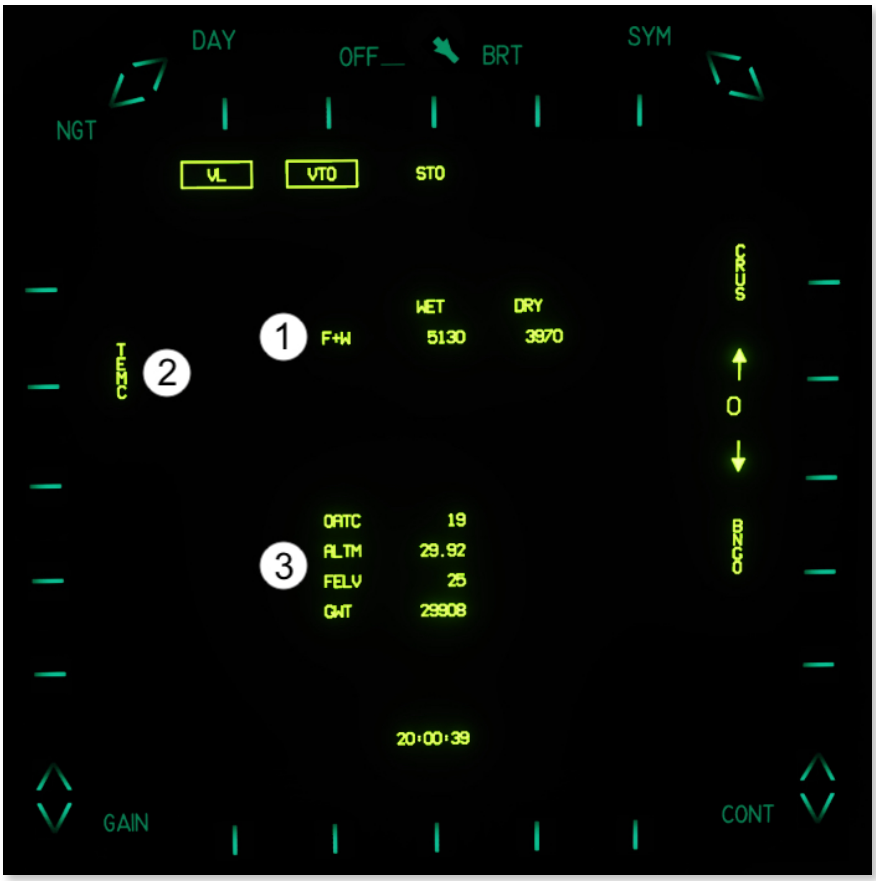
With Basic Page selected, the following options are available on the ODU page:

1. BAW (Basic Aircraft Weight): pressing this option shows the current weight of the aircraft on the Scratchpad in the UFC.

2. H20 (Water): pressing this option shows the current amount of remaining water on the Scratchpad in the UFC.

3. BDI (Basic Drag Index): pressing this option shows the current BDI value on the Scratchpad in the UFC.

VTO/VL Display



When VL is pressed, both VL and VTO become box and the VL / VTO VREST page is displayed. It contains the following data:

1. F + W (Fuel + Water): Shows the maximum combined weight of fuel and water (in pounds) aboard the aircraft at which the vertical takeoff or landing can be done, computed for *wet* (using water) or *dry* (without water) variant.

2. TEMC (or TEMF): this pushbutton allows the outside air temperature to be entered and displayed in units Fahrenheit (in which case TEMF is displayed) or Celsius (in which case TEMC is shown).

3. Additional information. This consists of:

OATC or **OATF**: depending of the selection made using pushbutton 4, this field shows the **Outside Air Temperature** in degrees **Celsius** or **Fahrenheit**.

ALTM: current altimeter in inches of mercury.

FELV: field elevation, which is used to compute the maximum allowable F+W weight. The displayed FELV is either computed or pilot entered via the ODU.

GWT: Aircraft gross weight, or the total weight of the aircraft including fuel, water, pilot, stores including hung stores, and rounds remaining including spent casings.

VTO/VL ODU OPTIONS

Whenever VTO or VL are boxed, the following options will be shown on the ODU:

GWT (Gros Aircraft Weight): pressing this option shows the current weight of the aircraft on the Scratchpad in the UFC.

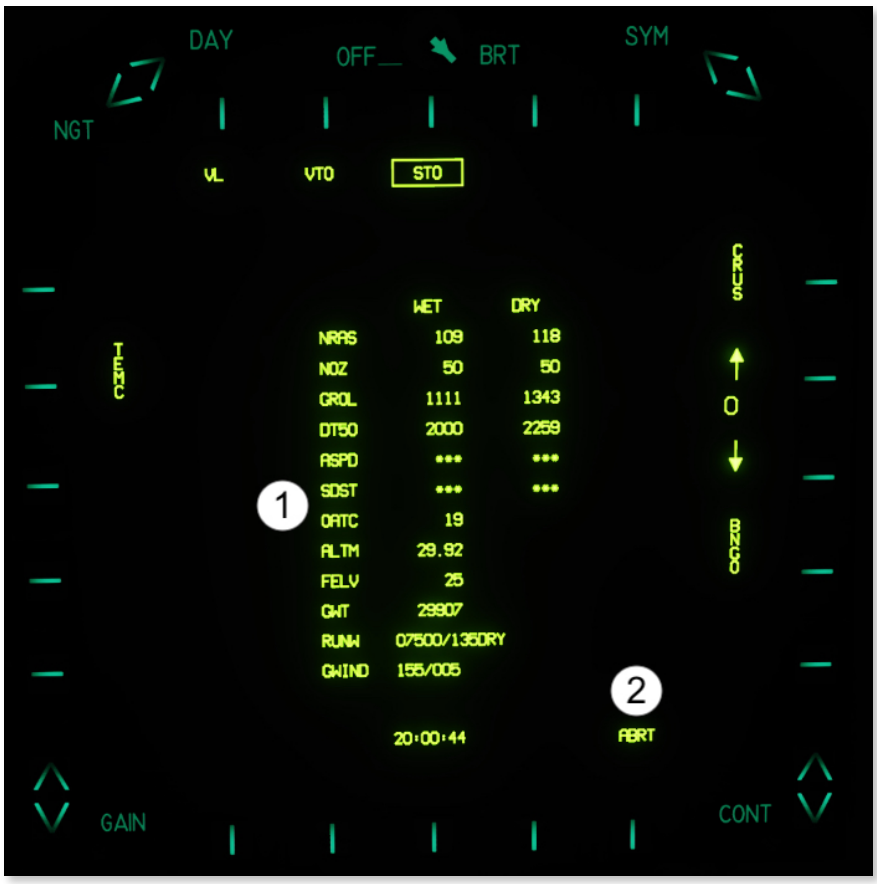
OATC or **OATF** (**Outside Air Temperture)**: shows the outside air temperature in degrees Celsius or Fahrenheit. Pressing ODU 2 switches between the two options.

FELV (Field elevation): pressing this option shows the elevation of current airfield on the Scratchpad and enables pilot's input.

ENG (Engine): allows the pilot to enter the engine data s. A colon appears next to the ENG legend indicating selection and new options are shown on the ODU.

The relative jet pipe temperature (RJPT), jet pipe temperature limit (JPTL), and relative hover (RHOV) options are displayed. Selecting anyone of these options enables the UFC scratch pad and keyboard for data entry. A colon appears to the left of the selected option.

STO Display



The **Short Takeoff Display** is pilot's main tool used by the pilot to make necessary calculations during short takeoffs, such as nozzle rotation airspeed, abort speed or stopping distance. When selected (as indicated by the boxed STO legend under pushbutton 8) the following data is shown:

1. STO information. Most of the values presented on this page are in two columns, for *wet* or *dry* takeoff. This includes:

NRAS (Nozzle Rotation Air Speed): indicates the airspeed at which nozzles should be rotated during the Short Takeoff in order to match the results shown under GROL and DT50 (see below). More information on NRAS can be found in the XXX section.

NOZ (Nozzle Setting in Degrees): displays the desired nozzle deflection to be used during given takeoff, which is dependent mainly on the hover weight ratio, but also other factors such as wind, runway length etc.

GROL (Ground Roll): indicates the minimum ground roll distance (in feet) required for short take off.

DT50 (Distance to 50 feet): indicates the linear distance in feet that needs to be covered before clearance of 50 foot obstacle can be achieved.

ASPD (Abort Speed): it needs to be computed and initially shows three asterisks. After relevant information is introduced into the mission computer (see below) and ABRT (abort) pushbutton is pressed, the maximum safe abort speed is displayed next to ASPD field for both *wet* and *dry* takeoff.

SDST (Stopping Distance): initially shows three asterisks. After relevant information is introduced into the mission computer (see below) and ABRT (abort) pushbutton is pressed, the approximate distance travel before coming to full stop is shown next to SDST field for both *wet* and *dry* takeoff.

OATC (Outside Air Temperature in degrees **Celsius**): see the description for the VTO / VL.

ALTM: current altimeter in inches of mercury.

FELV: field elevation, which is used to compute the maximum allowable F+W weight. The displayed FELV is either computed or pilot entered via the ODU.

GWT: Aircraft gross weight, or the total weight of the aircraft including fuel, water, pilot, stores including hung stores, and rounds remaining including spent casings.

RUNW (**Runway)**: displays runway distance (RDIST), runway heading (RHDG) and runway condition (RWET/ RDRY), which are all pilot entered. See STO Display ODU Options below.

GWIND (**Ground Wind**): indicates wind direction and speed at ground level. It also should be entered by the pilot.

The direction and speed of the wind can be found on the ESHD Data page under A/C or it can be obtained from the ATC.

2. ABRT (Abort) pushbutton. Used for the pilot to let the system compute the ASPD and SDST after all the relevant information is entered via the ODU. When selected, the ABRT legend is boxed and asterisks on the main page are replaced by the calculated values.

STO ODU OPTIONS

Whenever STO is boxed, the following options will be shown on the ODU:

GWT (Gros Aircraft Weight): pressing this option shows the current weight of the aircraft on the Scratchpad in the UFC.

OATC or **OATF** (**Outside Air Temperture)**: shows the outside air temperature in degrees Celsius or Fahrenheit. Pressing ODU 2 switches between the two options.

FELV (Field elevation): pressing this option shows the elevation of current airfield on the Scratchpad and enables pilot's input.

ENG (Engine): allows the pilot to enter the engine data s. A colon appears next to the ENG legend indicating selection and new options are shown on the ODU.

The relative jet pipe temperature (RJPT), jet pipe temperature limit (JPTL), and relative hover (RHOV) options are displayed. Selecting anyone of these options enables the UFC scratch pad and keyboard for data entry. A colon appears to the left of the selected option.

FDAT (Field Data): colonising this field opens another set of options on the ODU. These are used to input the airfield data into the mission computer.

RDIS (Runway Distance): when pressed, it allows you to enter the runway length in feet on the Scratchpad using the UFC keyboard. Press ENT to save the entered value.

RHDG (Runway Heading): when pressed, it allows you to enter the runway heading on the Scratchpad, using the UFC keyboard. Press ENT to save the entered value.

GWND (Ground Wind): indicates wind direction and speed at ground level. It also should be entered by the pilot.

RDRY (Runway Dry): depending on the conditions, colonise it when the runway (or improvised runway) is dry. Leave it uncolonised when the runway is wet.

All of the data introduced under FDAT will be shown next to RUNW and GWND on the STO display.

CRUISE DISPLAY

Cruise display is not used during takeoff or landing, but in-flight. It computes the best flight profile for altitude cruise (ACR) and optimum cruise (OPCR) performance.

When CRUS is selected (as indicated by the boxed CRUS legend under next to pushbutton 11) the following data is shown:

1. Selected waypoint. The number between the arrows indicates selected waypoint. Waypoint can be changed by pressing the increment (OSB 11) or decrement (OSB 13) pushbutton. Changing waypoint does not change waypoint selection on EHSI/EHSD display. Pressing the increment or decrement pushbutton for more than 0.8 seconds enables a quick access session allowing the pilot to select between all 60 waypoints, 30 markpoints, and 1 targetpoint.

2. CRUS data. Data is shown in two columns.

ACR (left column) displays the profile necessary to obtain the maximum cruise performance at the existing altitude.

OPCR (right column) displays the flight profile at which maximum cruise performance can be obtained.

Other lines are:

CAS (Calibrated Airspeed) indicates the best airspeed that should be obtained to increase aircraft's range at current altitude (under ACR) or the best airspeed that should be used at optimal altitude (under OPCR). Pilot can manually enter the desired speed used for calculations under OPCR (see below).

MACH (speed in Mach) indicates the best Mach number that should be obtained to increase aircraft's range at current altitude (under ACR) or the best Mach number that should be used at optimal altitude (under OPCR).

CALT (Cruise Altitude) in ACR column shows the current aircraft altitude in feet). Number in OPCR column indicates best altitude for use with other OPCR variables to increase maximum cruising range. Pilot can manually enter the desired altitude used for calculations under OPCR (see below).

RANG (Range to selected waypoint) in Nautical Miles.

RFUL (Remaining fuel) indicates remaining fuel in pounds after arriving at selected waypoint if ACR or OPCR profile is followed.

MRNG (Maximum Range) indicates maximum range that can be reached if the altitude, airspeed, and Mach of respective columns is followed. The MRNG computations allow a 800 pound fuel reserve.

WIND (wind direction and strength). Displayed ACR wind is computed from aircraft sensors. OPCR wind is a pilot entered value.

3. Aircraft Gross Weight and Drag Index. Aircraft weight is indicated by GWT and, again, displays the total weight of the aircraft including

fuel, water, pilot, stores including hung stores, and rounds remaining including spent casings.

Drag Index (**DI**) indicate total drag of aircraft and stores. DI can also be introduced manually by the pilot (see the Drag Index Values table for manual computations).

CRUS ODU options

Whenever CRUS is boxed, the following options will be shown on the ODU:

GWT (Gross Aircraft Weight): pressing this option shows the current weight of the aircraft on the Scratchpad in the UFC.

DI (Drag Index): pressing this option shows the current DI on the Scratchpad in the UFC. Pilot can manually change this value using the UFC keyboard and accepting the new value with the ENT key. Please refer to the Drag Index Values table for manual computations.

OWND (Optimum Cruise Wind): pressing this option shows the currently introduced wind direction and speed on the Scratchpad. Pilot can manually change this value using the UFC keyboard and accepting the new value with the ENT key.

The direction and speed of the wind can be found on the ACR column, on the ESHD Data page under A/C or it can be obtained from the ATC. It is not automatically computed by the aircraft for the OPCR column and needs to be introduced manually by the pilot there.

ALT (Cruise Altitude): pressing this option shows the desired altitude that should be used for OPCR computations on the Scratchpad. Pilot can manually enter the altitude he wants to calculate optimal range that should be kept for best range. Manual entries for ALT calculations are denoted with an asterisk preceding the CALT (*) next to the legend.

Instances, when pilot would need to change the optimal altitude are, for instance, when it is advisable to avoid the contrail altitude or when aircraft's oxygen supply is damaged and pilot needs to stay below 10 000 feet etc.

CAS (Calibrated Airspeed): pressing this option shows the desired calibrated airspeed that should be used for OPCR computations on the Scratchpad. Pilot can manually enter the speed he wants to calculate optimal range that should be kept for best range (within the limit of 600 knots CAS). Manual entries for ALT calculations are denoted with an asterisk preceding the CALT (*) next to the legend.

Here, examples could be escorting another flight with a given maximum speed. In this case after CAS is introduced into the system, OPCR column will show the altitude that should be attained for maximum range.

BINGO Display

The bingo display presents the best flight profile for altitude bingo (ABNG) and optimum bingo (OBNG) performance.

When BNGO is selected (as indicated by the boxed BNGO legend under next to pushbutton 14) the following data is shown:

1. Selected waypoint. The number between the arrows indicates selected waypoint for BNGO calculations. Waypoint can be changed by pressing the increment (OSB 11) or decrement (OSB 13) pushbutton. Changing waypoint does not change waypoint selection on EHSI/EHSD display. Pressing the increment or decrement pushbutton for more than 0.8 seconds enables a quick access session allowing the pilot to select between all 60 waypoints, 30 markpoints, and 1 targetpoint.

2. BNGO data is displayed in two columns:

ABNG (left column) displays the profile necessary to obtain the maximum bingo performance at the existing altitude.

OPCR (right column) displays the flight profile at which maximum bingo performance can be obtained.

CAS (Calibrated Airspeed) indicates the best airspeed that should be obtained to increase aircraft's range at current altitude (under ABNG) or the best airspeed that should be used at optimal altitude (under OBNG). Pilot can manually enter the desired speed used for calculations under OBNG (see below).

MACH (speed in Mach) indicates the best Mach number that should be obtained to increase aircraft's range at current altitude (under ABNG) or the best Mach number that should be used at optimal altitude (under OBNG).

CALT (Cruise Altitude) in ABNG column shows the current aircraft altitude in feet). Number in OBNG column indicates best altitude for use with other OBNG variables to increase maximum cruising range. Pilot can manually enter the desired altitude used for calculations under OBNG (see below).

RANG (Range to selected waypoint) in Nautical Miles.

RFUL (Remaining fuel) indicates remaining fuel in pounds after arriving at selected waypoint if ABNG or OBNG profile is followed.

MRNG (Maximum Range) indicates maximum range that can be reached in the direction of selected waypoint if the altitude, airspeed, and Mach indications of respective columns are followed. The MRNG computations allow a 800 pound fuel reserve.

WIND (wind direction and strength). Displayed ACR wind is computed from aircraft sensors. OPCR wind is a pilot entered value.

GWT (Aircraft Gross Weight) displays the total weight of the aircraft including fuel, water, pilot, stores including hung stores, and rounds remaining including spent casings.

DI (Drag Index) indicates total drag of aircraft and stores. DI can also be introduced manually by the pilot (see the Drag Index Values table for manual computations).

BNGO ODU OPTIONS

Whenever CRUS is boxed, the following options will be shown on the ODU:

GWT (Gross Aircraft Weight): pressing this option shows the current weight of the aircraft on the Scratchpad in the UFC.

DI (Drag Index): pressing this option shows the current DI on the Scratchpad in the UFC. Pilot can manually change this value using the UFC keyboard and accepting the new value with the ENT key. Please refer to the Drag Index Values table for manual computations.

OWND (Optimum Cruise Wind): pressing this option shows the currently introduced wind direction and speed on the Scratchpad. Pilot can manually change this value using the UFC keyboard and accepting the new value with the ENT key.

ALT (Cruise Altitude): pressing this option shows the desired altitude that should be used for OPCR computations on the Scratchpad. Pilot can manually enter the altitude he wants to calculate optimal range that should be kept for best range. Manual entries for ALT calculations are denoted with an asterisk preceding the CALT (*) next to the legend.

CAS (Calibrated Airspeed): pressing this option shows the desired calibrated airspeed that should be used for OPCR computations on the

Scratchpad. Pilot can manually enter the speed he wants to calculate optimal range that should be kept for best range (within the limit of 600 knots CAS). Manual entries for ALT calculations are denoted with an asterisk preceding the CALT (*) next to the legend.

12.2.5 DRAG INDEX VALUES

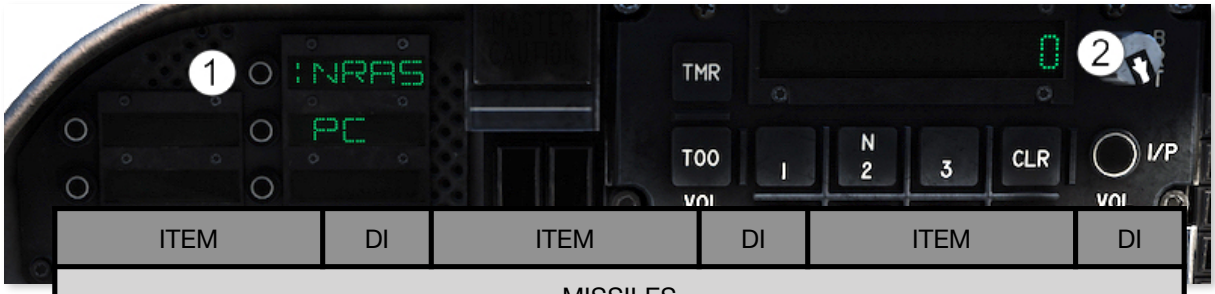
The table below should be used to manually calculate the Drag Index (DI) later introduced into the CRUS or BNGO pages. Basic drag value for clean AV-8B N/A aircraft is 1.4.

12.2.6 NRAS (NOZZLE ROTATION AIRSPEED)

NRAS stands for Nozzle Rotation Airspeed cue. It is used to notify the pilot that the required airspeed at which nozzles should be rotated during Short Takeoff has been reached. On pictures below, the right one shows airspeed before set NRAS is reached; the left one shows airspeed after NRAS is reached.

With VSTOL mode selected while weight-on-wheels, the nozzle rotation airspeed (NRAS) cue is set by pressing the NRAS option on the ODU

(**1**), typing the desired airspeed (up to 160 knots) on the UFC (**2**), then



ITEM	DI	ITEM	DI	ITEM	DI
MISSILES					
AIM-9L/M	2.25	AGM-65E	3.25	AGM-65F	3.20
AGM-122	2.25				
GENERAL PURPOSE BOMBS					
Mk-81	1.00	Mk-82	1.35	Mk-83	2.25
LASER GUIDED BOMBS					
GBU-12	3.25	GBU-16	5.50		
CLUSTER BOMBS					
Mk-20	4.50	CBU-99	4.50		
ROCKETS					
ZUNI	0.75	2.75 INCH	0.25		
ROCKET LAUNCHERS					
LAU-10 ZUNI (FULL)	3.40	LAU-62 2.75 (FULL)	5.30	LAU-68 2.75 FULL	1.70
LAU-10 (EMPTY)	5.50	LAU-62 2.75 (EMPTY)	10.25	LAU-68 2.75 EMPTY	3.25
OTHER					
SUU-25 with LUU-2	4.25	TPOD (OPEN)	4.0	TPOD (SBY)	2.0
EXT. FUEL TANK	7.75	GAU-12 SYSTEM	6.70	REF. PROBE (EXT)	2.7

pressing ENT.

The airspeed will be boxed unless REJ 2 is selected on the HUD control panel.

12.2.7 PITCH CARETS

Pitch carets are a visual cue displayed on the HUD and used during Conventional and Short Takeoffs by putting the Depressed Altitude Symbol (Witch's Hat) on the Pitch Carets.

Pitch Carets are also set up on the ODU and the Scratchpad, set by colonising the PC option on the ODU (**1**), typing the desired angle on the UFC (between 0 and 30 degrees, **2**) and then pressing ENT.

12.3 COLD START

In most of the missions pilots will be required to go through a full start procedure of the aircraft, which can be a lengthy process. Only on rare occasions you will start a mission in an already prepared jet - be it after hot refueling between two consecutive missions or if you're sitting on alert. Therefore it is important to learn the whole process by heart. This chapter will guide you step by step through it.

NOTE: for interactive version of information contained in this chapter, please refer to separate training missions mentioned at the beginning of each part.

12.3.1 COCKPIT PREPARATION

Following checks should be performed before starting the aircraft (going from the back of the left console through the front panel to the back of the right console):

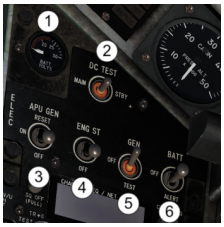
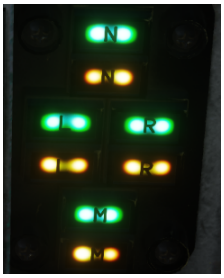
1. DECS enable switch	OFF.
2. Fuel shutoff handle	OFF.
3. Engine RPM switch	LO.
4. Engine fuel control switch	POS 2.
5. LIDS switch	NORM.
6. Oxygen switch	OFF.
7. H2O dump	OFF.
8. Exterior lights	AS REQUIRED.
9. A/R switch	IN.
10. Left and right wing dump switches	NORM.
11. Left and right boost pump switches	NORM.
12. FUEL PROP	ON.
13. Throttle	OFF.
14. JPTL switch	ON.
15. Manual fuel switch	OFF.
16. Parking brake	ON.
17. SAS	SET.
a. Pitch	ON.

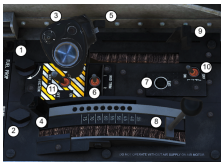
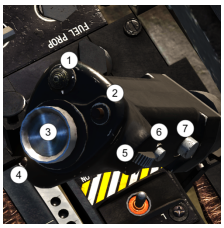
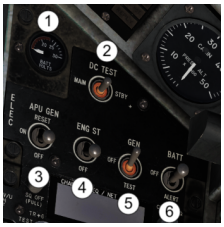
b. Roll	ON.
c. Yaw	ON.
18. Q-feel switch	ON.
19. Alt Hold / AFC	OFF.
20. Rudder pedal shaker switch	ON.
21. Landing light switch	OFF.
22. **ANTISKID** switch	ON.
23. Landing gear handle	DOWN.
24. LDG GEAR EMER BATT	CHECK
25. Flap switches	AUTO and OFF.
26. Water switch	OFF.
27. MASTER ARM	OFF.
28. Armament control panel	SAFE/NORM.
29. IR cool switch	OFF.
30. DDI, HUD, COMM, UFC	AS DESIRED.
31. Clock	SET.
32. FLIR switch	AS DESIRED.
33. VRS switches	AUTO and HUD
34. DMT switch	AS DESIRED.
35. INS mode selector knob	OFF.
36. DP switch	AUTO.
37. MC switch	AUTO.

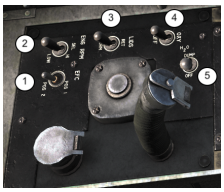
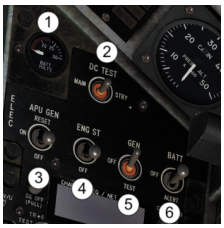
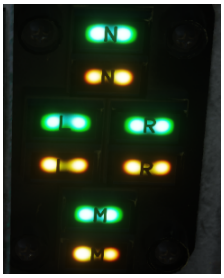
38. Probe Heat switch	AUTO.
39. Circuit breakers (7)	IN.
40. ECM control panel:	
a. RWR	AS DESIRED.
b. Expendables	OFF.
c. ECM	OFF.
41. Battery switch	OFF.
42. Generator switch	GEN.
43. V/UHF radio remote control	T/R or T/R + G.
44. ACNIP panel	AS DESIRED.
45. IFF	NORM.
46. Internal lights panel	AS DESIRED.
47. ECS panel.	
a. Temperature controller	AUTO.
b. Aft bay equip switch	ON.
c. DEFOG switch	NORM.
d. Cabin pressure switch	NORM.
48. Video recorder	LOAD TAPE, STBY/REMOTE

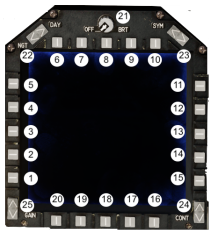
12.3.2 STARTING THE AIRCRAFT

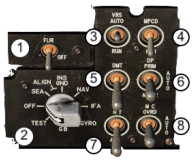
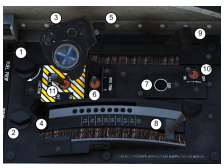
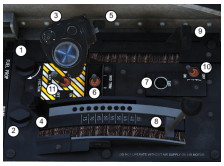
After verifying that all switches are in the correct positions, you can begin the process of starting up the aircraft. In order to do this, you the following steps should be followed:

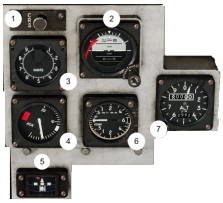
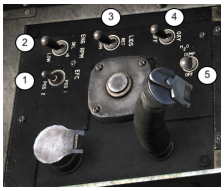
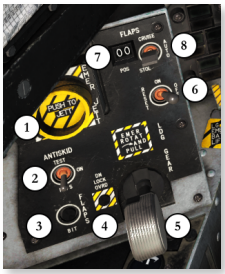
1		Set the **Battery Switch** (6) to BATT position. Verify that the voltage on the DC voltmeter shows at least 24.5 Volts.
2		Conduct a test of the warning and caution lights by holding the **compass light / lights test switch (1)** in the lights test (LTS TEST) position. Look around the cockpit to ensure that all warning, caution, landing gear, combat switch panel, HUD master mode, in-flight refueling, and threat lights are operational. Reset Master Caution and Master Warning buttons.
3A		Check your **accumulator pressure** for indications of at least 1000 PSI
3B		Check your **brake pressure** for indications of at least 1500 PSI
4		Make sure that the landing gear indicator on the left console shows four gear down and locked (green)

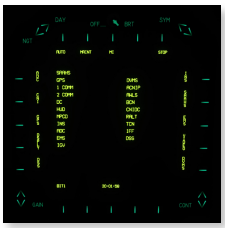
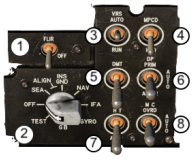
5		**Test the throttle quadrant.** First, release the parking brake (9). Then, move the throttle to the full power position to trip the Jet Pipe Temperature Limiter (JPTL, 10). Watch that the switch disengages and listen for the audible caution. Next, pull the throttle back to idle, lift the throttle cutoff lever, and pull the throttle into the OFF position. Reset the JPTL switch to ON and re-engage the parking brake.
6		**Check the igniters.** Press the airstart button (6) on the throttle to activate the igniters and listen for an irregular crackle, indicating that both igniters are firing. Note that both boost pump lights should extinguish during this check, since the DC portion of the boost pumps is active while they fire.
7-8		Place the **DECS enable switch** and the **Fuel SHUTOFF handle** into the ON position.
9		Perform a Built-In Test (BIT) of the **Engine Display Panel (EDP)** by pressing the BIT button at the upper left of the EDP. Watch for the tumblers to rotate through available numbers, and the Overtemp, 15 Second, and water flow lights to illuminate. After a successful BIT, all lights will extinguish and the nozzle indicator will return to between 0 and 10°.
10		Perform a **Fuel Panel BIT** by setting the Bingo bug to 4000 lbs or greater and turning the selector knob to BIT and holding it in position. The left feed group will indicate 1400 ± 100 pounds, the right feed group will indicate 2400 ± 100 pounds, and the totalizer will read 3800 ± 200 pounds. The Master Caution, left and right full advisory lights on the arch (LEFT and RIGHT), and 250 pound flashers (L FUEL and R FUEL) will flash. The LOAD and BINGO caution lights will also illuminate. Return the selector knob back to TOTAL or INT position and set the Bingo bug to the briefed value.
12		Close the **canopy**.
13		Place the **APU Generator switch (3)** in the ON position.
14		Prior to engine start, conduct a **Digital Engine Control System (DECS) power check** by moving the DECS enable switch to OFF. Look for the Electronic Fuel Control (EFC) and JPTL warning and caution lights to illuminate. Return the DECS enable switch to the ON position.

15		Cycle the **EFC switch (1)** to POS 1. Your EFC caution light should momentarily flash, with an associated audible alert. This verifies that the redundant Digital Electronic Control Unit (DECU) is functional prior to starting the engine. Reset the switch to POS 2.
16		Signal to the Plane Captain to **disconnect the external power.**
17		Place the **Engine Start switch (4)** in the forward ENG ST position. Listen for the APU to decelerate for 10 seconds before the GTS engages to start the engine.
18		When RPM reaches approximately 3%, bring the **throttle** into the idle position. Engine light is indicated by a jet pipe temperature (JPT) rise (6) and rapid RPM increase (5). Check that the start switch automatically shuts off prior to 15% RPM. Verify that the engine idle RPM stabilises between 28.4 and 29% and that the JPT is below 545° C.
19		Check that the hydraulic 1 and 2, and brake accumulator gauges read 3000 ± 200 PSI. Fully depress the toe brakes and verify that the brake pressure gauge reads a minimum of 2700 PSI.
20		Conduct another lights test by holding the c**ompass light / lights test switch** in the aft LTS TEST position for about 5 seconds, waiting for the LIDS caution light to illuminate. This delay is to check the electrical circuitry on the LIDS fence. Upon release of the compass light / lights test switch, all remaining lights indicate a current condition of the aircraft.
21		Re-check the landing gear indicator on the left console and make sure that it shows four gear down and locked (green)

22		Turn on your MFCDs by rotating the **OFF / BRT knob** (21) at the top of each panel clockwise and selecting DAY or NGT as appropriate to the current lighting conditions.
23		Turn on your HUD by rotating the **BRT knob (2)** on the HUD control panel clockwise, setting the brightness as desired. Select **NORM** on the **NORM / REJ 1 / REJ 2 switch (1)** and select the desired mode with the D**AY / AUTO / NIGHT switch (3)** as appropriate.
24		Turn on **both radios** by adjusting the **volume knobs (7)** as desired. Set the **BRT knob (2)** to a level that allows you to read the ODU, scratchpad, and COMM channel windows in the current lighting conditions.
25		To monitor the engine, press the **pushbutton 18 twice**, and then select ENG with **pushbutton 11**. Check that your Inlet Guide Vane (IGV) angle is between 31 and 39° at Idle RPM, and press the Jet Pipe Temperature (JPT) button with pushbutton 10 to reset the sortie JPT to the current indicated temperature.
26		You may open the **canopy**.
27		Align your INS. Make sure that the **parking brake** is SET. Enter the EHSD, then **DATA** page, then **A/C**.
28		Using the buttons on the **ODU,** enter aircraft current LAT / LONG position, as well as **MAGV** (Magnetic Variation) using the Scratchpad on the UFC.

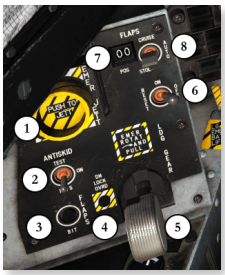
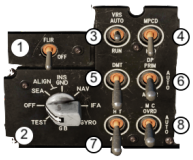
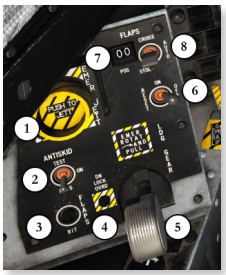
29		Rotate the **INS knob (2)** clockwise to the **Ground Align (GND ALIGN)** setting and ensure the MPCD initiates with quality ATT NOT OK and time counting upward. After approximately one minute you will notice QUAL counting down until it reaches 0.7. **NOTE:** *Do not release the parking brake until the alignment is complete.*
30		Place the **DMT switch (5)** in the DMT or ON position to power on the Dual-Mode Tracker.
31		Press the **TACAN (TCN) button** and press the ON OFF button, verifying the ODU is set to Transmit / Receive. Press the **Altitude (ALT) button** and press the ON OFF button to activate the audible alert.
32		Power on the FLIR by placing the **FLIR switch (1)** in the FLIR or ON position. The FLIR sensor will begin its cool down period.
33		Conduct a JPT Limiter check. Place the **JPTL switch (10)** in the OFF position and observe a rise in RPM, Fuel Flow, and Jet Pipe Temperature on the EDP as the aircraft switches from the Short Lift Dry schedule and limit to the Short Lift Wet schedule and limit. You will hear an audible warning and observe JPTL flashing on the master warning panel. Return the JPTL switch to the ON position and observe the associated drop in RPM, Fuel Flow, and Jet Pipe Temperature on the EDP.
34		Conduct a Manual Fuel System (MFS) check by placing the momentary **Manual Fuel (MAN FUEL) switch (11)** behind the throttle in the ON position. Observe a rise in RPM and Jet Pipe Temperature on the EDP, listen for the audible caution, and observe the MFS light to illuminate on the Master Caution panel. Return it to OFF position.
35		Check the Water Injection system. Place the **Water (H2O) switch (1)** in the takeoff (TO) position and observe an increase in RPM, Fuel Flow, and Jet Pipe Temperature as the DECS switches to the wet datum. Then place it in the Landing (LDG) position. Finally, switch it back to OFF and observe a return to IDLE RPM.

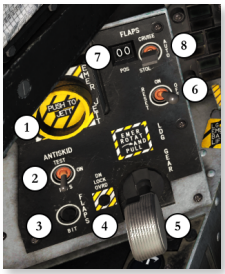
36		Check the Enhanced Variable Inlet Guide Vane Control System (EVICS). First, release the parking brake. Select the ENG page on your MPCD. Hold your brakes and advance the throttle to 55% corrected high-pressure compressor (COR COMP) RPM and then return to idle. Press the MENU button with pushbutton 18, press the BIT button (P/B 6), and observe that there are no error codes in the IGV system. Set your parking brake.
37		Conduct a Trim check by trimming the aircraft's rudder and ailerons left and right through their full range of motion and verifying an appropriate response on the **rudder and aileron trim gauges (3)**.
38		Cycle the stabilator trim through its full forward and aft range of motion, verifying an appropriate response on either the **EDP (4)** or AMPCD ENG page. Set the stabilator to 4° nose down. This keeps the front RCS duct closed so that you don't inadvertently blow foreign object debris, or FOD, into the engine intake while taxiing.
39		Check the standby instruments by verifying they match other indicators in the cockpit. Uncage the attitude indicator 1 minute after power was applied to the gyro. Turn the cage knob to set the proper attitude. Set the barometric pressure on the altimeter and make sure that the barometric altimeter matches the airfield elevation listed in the kneeboard.
40		Enable the On-Board Oxygen Generating System, or OBOGS, by moving the **Oxygen switch (4)** to the OXY, or ON position.
41		Set the **FLAPS switches (6, 8)** to ON and AUTO. Place the **FLAPS Mode switch (8)** to the Short Takeoff and Landing (STOL) position and verify that the Aileron Droop (DROOP) light illuminates. This indicates that the aileron neutral positions are set to 15° down, producing greater lift in slow speed regimes. Set the FLAPS Mode switch to CRUISE, watch that the DROOP light extinguishes, and verify Flaps position at 5°.
42		Perform the flight controls check. Move the flight controls through their full range of motion, starting with full left and right rudder deflection. Next, check stabilator by pushing the stick full forward and checking the EDP stabilator position at 11° down. Pull the stick full aft and check EDP stabilator position at 10° up. Finally, check aileron function with full left and right deflection, ensuring that you can visually see the up aileron above the plane of the wing.

43		Initiate the SAAHS BIT from the BIT 1 page on the right MPCD. Press the SAAHS button (P/B 12), and observe TEST appear next to the SAAHS legend, as well as the illumination DEP RES, PITCH, ROLL, and YAW caution / advisory lights. A successful BIT is indicated by all lights extinguishing.
44		Next, conduct a Stores / BIT check and review the Stores Management System Function Failure (SMSFF) page. Select MENU (P/B 18) then STRS (P/B 4) and look for any weapon failures or flashing weapons fail indications.
45		Conduct a check of Display Processor function by cycling the **DP switch (6)** between primary (PRIM) and alternate (ALTER). Set the switch back to AUTO, which will randomly select an operational channel and provide automatic re-selection upon channel failure.
46		Test the Air Refueling Probe for function. Extend the air refueling probe by moving the **A/R switch (1)** to the OUT position. Look for the green READY light on the left canopy arch, and retract the probe by moving the A/R switch to the IN position. Verify that the green READY light extinguishes.
47		Verify vertical landing aircraft performance against the aircraft's weight, current environmentals, and the dimensions of the selected runway surface. This is done through the Vertical Takeoff, Vertical Landing, Range Endurance, Speed and Time computer. This is also called V/STOL-REST, or just VREST for short.
48		Adjust your cockpit lighting and set your displays. Set your left MPCD to the Electronic Horizontal Situation Display (EHSD) by returning to the MENU page with P/B 18 and pressing the EHSD button (P/B 2). Set your right MPCD to the Forward Looking Inrared (FLIR) page by returning to the MENU page with P/B 18 and pressing the FLIR button (P/B 01).

12.3.3 BEFORE TAXI CHECKLIST

Once the aircraft is started and all systems are ready, before starting to taxi the pilot should perform several additional checks and steps.

1		Verify that the parking brake is set and turn the ANTISKID switch to ON.
2		Check the EHSD for proper INS alignment. The goal for INS alignment is a QUAL readout of less than 1.0 with an OK indication.
3		Rotate the **INS switch (2)** to the NAV or In-Flight Alignment (IFA) position once the aircraft has a satisfactory alignment and verify a tightly-coupled GPS and INS with a "POS/INS" indication at the lower right of the EHSD.
4		Verify that the aircraft is properly configured for taxi by checking that it is in V/STOL HUD master mode, nozzles are set to 10°, FLAPS Mode is in CRUISE, FLAPS POS is 5°, and the aircraft is properly trimmed 4° nose down.
5		Test the brakes and Nose Wheel Steering (NWS) by moving the ANTISKID switch to the NWS position and obtain taxi clearance from Ground.
6		Release the parking brake and brake pedals and begin to taxi forward. Tap the pedals to verify proper operation of the brakes. With the aircraft slowly rolling forward, press the Undesignate / NWS pinky button on the stick to activate high gain NWS and saw the pedals left and right to verify proper function and range of motion of the NWS system.

7		Release brake pressure and begin rolling to a speed of about 15 knots. Follow the yellow taxiway line and turn left, being careful not to ride the brakes. As you leave the line, bring the nozzles to 10°. Even at idle power you can start to build up excessive ground speed.
8		As you approach the active runway, smoothly apply brake pressure and come to a stop toward the edge. Set your parking brake and deselect NWS by placing the ANTISKID switch in the ON position. Verify the SKID caution light extinguishes.

You are now ready to try Training Mission 02 (COLD START) included with the AV-8B Night Attack module.

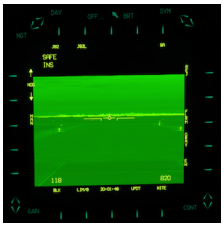
12.4 CONVENTIONAL TAKEOFF

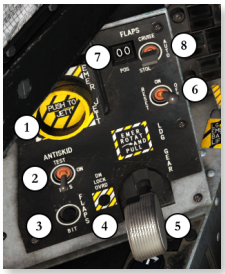
Conventional takeoffs (or CTOs) aren't the default type of takeoff although they are the easiest to perform. The Harrier was designed from the ground up as a V/STOL aircraft and as such CTOs tend only to be used when asymmetric loadings or high crosswinds preclude the use of any other type of takeoff.

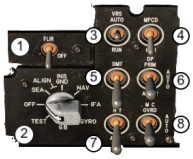
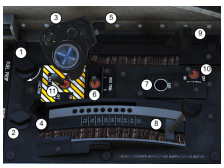
Still, the CTO entails the lowest workload and is probably the safest aerodynamic takeoff for the Harrier. It might be considered by some to be beyond the“purist” design intent of the aircraft, but it allows the pilot to take off with a minimum of workload.

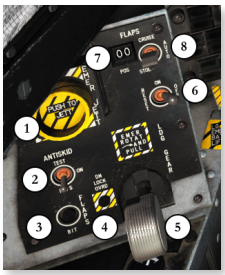
12.4.1 CONVENTIONAL TAKEOFF PROCEDURE

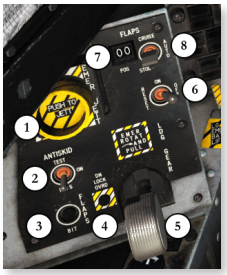
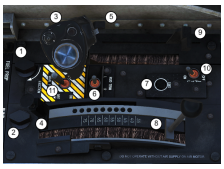
Following steps should be observed for proper conventional takeoff in the AV-8B N/A:

1		Set the Clock by pressing the Timer (TMR, **4**) button on the UFC. Select TTT with ODU-2 and then press ODU-1 and verify that the clock shows current time. Press ODU-5 and check that the UTC time shows 4 am. Verify that this is the same as the time shown on the cockpit watch and on the HUD.
2		Program your weapons via the UFC Weapons (WPN, **8 right**) button and ODU.
3		Set your FLIR by pressing MENU (P/B 18) and then FLIR (P/B1). Set the mode to Black or White by pressing pushbutton 20.
4		Set up your TACAN by pressing the TCN (**8**) button. Enter desired channel on your scratchpad and press ENTER. Next, turn it ON by pressing the ON / OFF button.
5		Set up your Video Recording System by setting your VRS and MFCD / HUD switches as desired.
6		Set your electronic countermeasures switches by performing a BIT and monitoring for failures. This isn't necessary on our FAM flight so we will skip it.

7		Set your Radar altimeter low altitude warning to desired value (usually 4900 feet). First press ALT button on your UFC. Next, colonise GPS with ODU button 3 and check that the Ground Proximity Warning System (GPWS) is colonised. Type "4900" and press ENTER.
8		Confirm that your canopy is locked and the canopy close light is extinguished.
9		Make sure that the ejection seat is armed by checking that the ground safety control handle on the right side of the seat is closed and pointing up.
10		Ensure the ANTISKID (**2)** switch is in the ON position.
11		Next, we will check our Abort numbers for the field we're on. On the right MPCD, select MENU (P/B 18), select VREST (VRST) (P/B 8), and box Short Takeoff (STO) (P/B 3).
12		On the ODU, select Field Data (FDAT) with ODU button 4, colonize Runway Distance (RDIS) with ODU button 1, and input a runway length into the scratchpad, confirming your entry with the Enter (ENT) button on the UFC.
13		Colonize Runway Heading (RHDG) with ODU button 2, enter a runway heading (degrees magnetic), and confirm your entry with the Enter (ENT) button on the UFC.
14		Colonize Ground Wind (GWND) with ODU button 3, enter a ground wind direction and magnitude, and confirm your entries with the Enter (ENT) button on the UFC.

15		Calculate your Abort criteria by pressing the Abort (ABRT) button (P/B 16, **2**) on your VREST STO page. Your Abort Speed (ASPD) and Stopping Distance (SDST) values will be displayed. We will talk about others during the Short Take Off and Landing lesson.
16		Place your Altitude (ALT) switch **(6)** in the Radar (RDR) position.
17		Make sure that your INS knob **(2)** is in the IFA position to ensure a tightly coupled GPS and INS throughout your flight.
18		Turn your Approach light **(2)** ON.
19		Begin "one finger" checks by pressing the V/STOL Master Mode button to colonize the ODU with V/STOL options. Select Nozzle Rotation Airspeed (NRAS) with ODU button 1 and enter a value of 135 knots in the scratchpad. Confirm entry with the Enter (ENT) button on the UFC.
20		Select Pitch Carets (PC) with ODU button 2 and verify a default setting of 14° in the scratchpad and confirm with ENT button
21		Ensure the Short Takeoff (STO) stop lever **(4)** is stowed in its full aft position.
22		Trim the Stabilator **(4)** to 2° nose down.

23		Set Flaps to AUTO, observe 25° in the Flaps Position indicator, and verify that no warning / caution / advisory lights are illuminated. Set the nozzle lever to 50° and verify that the Engine Display Panel matches and that the flaps remain at 25° with no DROOP light. Reset the nozzle lever to 10°.
24		Request permission from tower to take the active runway. When you receive the clearance, release the brakes and taxi onto the runway, steering the aircraft onto the runway centerline.
25		Select MENU on the right AMPCD (P/B 18), select Engine (ENG) (P/B 11), and press Acceleration (ACCEL) (P/B 16). Keep your wheel brakes pressed.Advance the throttle to just above 60%, then reduce power to maintain 60%. The aircraft will time how long it takes for the engine to spool between 35% and 60%. Verify that this value is between 2.4 and 3.1 seconds on the ENG page.
26		Place the nozzles at 30° and check that the duct pressure **(2)** is between 45 and 47 PSI. Once verified, place the nozzles back at 10°.
27		On the left MPCD, select EHSD with P/B 2 or Sensor Select Switch Left. On the right MPCD, select FLIR with Sensor Select Switch Right. Two-Finger Checks are complete.
28		Initiate your takeoff. Engage Nose Wheel Steering by holding the NWS switch on your stick. Keep your wheel brakes pressed.
29		Advance the throttle to full power. Release the brakes before the tires skid. Verify "top end" RPM is achieved. Steer the aircraft for centerline.
30		You will begin to have aerodynamic control of the rudder at 50-60 knots. At 135 knots, indicated by the box around your airspeed indicator, rotate with slight aft stick.

31		As the aircraft leaves ground effect, apply forward stick to set and keep the witch's hat indicator inside the pitch carets, ensuring a positive rate of climb.
32		Raise the landing gear by placing the Landing Gear handle **(5)** in the UP position.
33		Nozzle out to 0° by advancing the nozzle lever fully forward **(8)**. With nozzles aft, your duct pressure should read between 0 and 3 PSI. Do not exceed 300 knots.
34		Check your V/STOL HUD to verify flaps and nozzles are set as desired and when satisfied, select the NAV master mode button **(2)**.

You are now ready to try Training Mission 03 (CONVENTIONAL TAKEOFF AND BASIC HANDLING) included with the AV-8B Night Attack module.

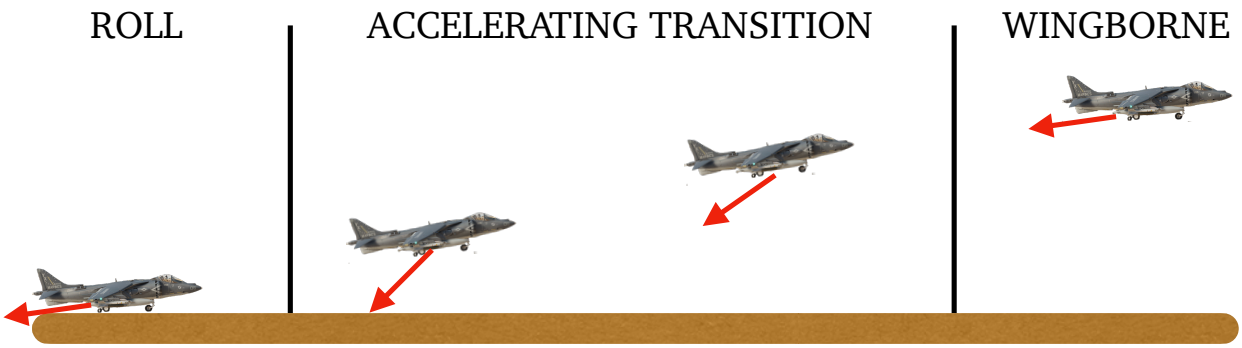
12.5 SHORT TAKEOFF (STO)

A short takeoff, or STO, is the general-purpose and most widely used takeoff type, with nearly infinite combinations of speed and nozzle angles to account for varying payloads and environmental conditions. This remarkable capability allows Marine commanders to carry this aircraft with them from ship to shore and operate almost anywhere, from a seized and damaged airfield to a small section of road.

This chapter will describe the general philosophy behind the STOs, followed by the detailed checklist that can also be found in the training mission.

Short Takeoff Basics

STO is a type of semi-jetborne takeoff, which is characterised by using the nozzles to enable the aircraft to get airborne earlier, ie. without sufficient speed needed for the CTO. All STOs end with an accelerating transition to wingborne flight.

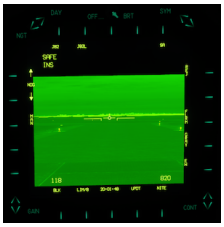


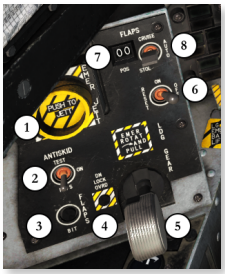
The red arrow shows the nozzle angle during all three phases of STO. The accelerating transition begins once the aircraft is clear of ground effect and at an altitude sufficient to avoid obstacles and introduction of FOD onto the landing surface. A slight climb should be maintained throughout the transition manuever. Accelerating transitions are performed using a capture attitude technique - meaning the aircraft is rotated in pitch until the depressed attitude symbol, or Witches Hat, coincides with the pitch carets. The capture attitude technique decreases pilot workload, as well as reducing the probability of having AOA excursions early in the takeoff maneuver due to pilot induced pitch oscillations. The nozzles are gradually rotated aft.

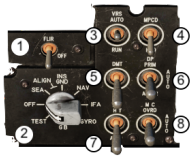
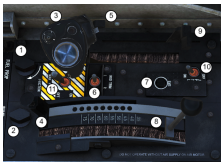
The liftoff occurs at a speed well below wingborne flight and a busy follow-on accelerating transition is required, any subtle unknowns will have maximum and sudden effect on the aircraft - things like wind variables, GC location, asymmetries, etc. It behooves the pilot, then, to be vigilant of wind directions, known asymmetries on his airplane, and performance margins, and take them all into account for the liftoff.

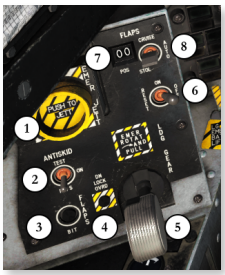
12.5.1 SHORT TAKEOFF PROCEDURE

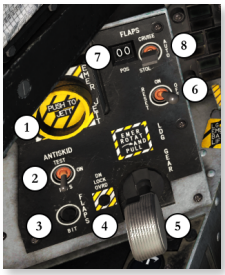
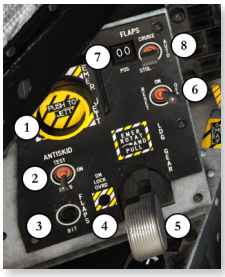
Following steps should be observed for proper conventional takeoff in the AV-8B N/A:

1		Set the Clock by pressing the Timer (TMR, **4**) button on the UFC. Select TTT with ODU-2 and then press ODU-1 and verify that the clock shows current time. Press ODU-5 and check that the UTC time shows 4 am. Verify that this is the same as the time shown on the cockpit watch and on the HUD.
2		Program your weapons via the UFC Weapons (WPN, **8 right**) button and ODU.
3		Set your FLIR by pressing MENU (P/B 18) and then FLIR (P/B1). Set the mode to Black or White by pressing pushbutton 20.
4		Set up your TACAN by pressing the TCN (**8**) button. Enter desired channel on your scratchpad and press ENTER. Next, turn it ON by pressing the ON / OFF button.
5		Set up your Video Recording System by setting your VRS and MFCD / HUD switches as desired.
6		Set your electronic countermeasures switches by performing a BIT and monitoring for failures. This isn't necessary on our FAM flight so we will skip it.

7		Set your Radar altimeter low altitude warning to desired value (usually 4900 feet). First press ALT button on your UFC. Next, colonise GPS with ODU button 3 and check that the Ground Proximity Warning System (GPWS) is colonised. Type "4900" and press ENTER.
8		Confirm that your canopy is locked and the canopy close light is extinguished.
9		Make sure that the ejection seat is armed by checking that the ground safety control handle on the right side of the seat is closed and pointing up.
10		Ensure the ANTISKID (**2)** switch is in the ON position.
11		Next, we will check our Abort numbers for the field we're on. On the right MPCD, select MENU (P/B 18), select VREST (VRST) (P/B 8), and box Short Takeoff (STO) (P/B 3).
12		On the ODU, select Field Data (FDAT) with ODU button 4, colonize Runway Distance (RDIS) with ODU button 1, and input a runway length into the scratchpad, confirming your entry with the Enter (ENT) button on the UFC.
13		Colonize Runway Heading (RHDG) with ODU button 2, enter a runway heading (degrees magnetic), and confirm your entry with the Enter (ENT) button on the UFC.
14		Colonize Ground Wind (GWND) with ODU button 3, enter a ground wind direction and magnitude, and confirm your entries with the Enter (ENT) button on the UFC.

15		Calculate your Abort criteria by pressing the Abort (ABRT) button (P/B 16, **2**) on your VREST STO page. Your Abort Speed (ASPD) and Stopping Distance (SDST) values will be displayed. We will talk about others during the Short Take Off and Landing lesson.
16		Place your Altitude (ALT) switch **(6)** in the Radar (RDR) position.
17		Make sure that your INS knob **(2)** is in the IFA position to ensure a tightly coupled GPS and INS throughout your flight.
18		Turn your Approach light **(2)** ON.
19		Begin "one finger" checks by pressing the V/STOL Master Mode button to colonize the ODU with V/STOL options. Find the Dry or Wet Nozzle Rotation Airspeed on the VREST STO page. Select Nozzle Rotation Airspeed (NRAS) with ODU button 1 and enter a value derived from the STO page in the scratchpad. Confirm entry with the Enter (ENT) button on the UFC.
20		Select Pitch Carets (PC) with ODU button 2 and verify a default setting of 14° in the scratchpad and confirm with ENT button.
21		Set the Short Takeoff (STO) stop lever **(4)** to the Dry Nozzle (NOZ) value calculated on the VREST STO page on your right MPCD.
22		Trim the Stabilator **(4)** to 2° nose down.

23		Set Flaps to STOL, observe 25° in the Flaps Position indicator, and verify that no warning / caution / advisory lights are illuminated other than DROOP, which can be on.
24		Select MENU on the right MPCD (P/B 18) and select Engine (ENG) (P/B 11). Set the nozzle lever to the STO stop and verify that the Engine Display Panel matches the HUD. Verify that the flaps adjust to 62° and that the Flaps Indicator matches the HUD with DROOP light illuminated. Reset the nozzle lever to 10°.
25		Request permission from tower to take the active runway. When you receive the clearance, release the brakes and taxi onto the runway, steering the aircraft onto the runway centerline.
26		Box Acceleration (ACCEL) (P/B 16) on the Engine (ENG) page on your right MPCD. Hold the brakes and advance the throttle to just above 60%, then reduce power to maintain 60%. The aircraft will time how long it takes for the engine to spool between 35% and 60%. Verify that this value is between 2.4 and 3.1 seconds on the ENG page.
27		Place the nozzles at 30° and check that the duct pressure **(2)** is between 45 and 47 PSI. Once verified, place the nozzles back at 10°.
28		On the left MPCD, select EHSD with P/B 2 or Sensor Select Switch Left. On the right MPCD, select FLIR with Sensor Select Switch Right. Two-Finger Checks are complete.
29		Initiate your takeoff. Engage Nose Wheel Steering by holding the NWS switch on your stick. Keep your wheel brakes pressed.
30		Advance the throttle to full power. Release the brakes before the tires skid. Verify "top end" RPM is achieved. Steer the aircraft for centerline.

31		At the calculated NRAS speed, indicated by the box around your airspeed indicator, quickly move the nozzle lever to the STO stop and allow the aircraft to take off. Do not rotate with the stick.
32		As the aircraft leaves ground effect, smoothly capture 4-6° of pitch. Keep the witch's hat indicator inside the pitch carets, ensuring a positive rate of climb.
33		Raise theRaise the landing gear by placing the Landing Gear handle in the UP position. This will reduce engine temperature and extinguish the "15 SEC" light, if lit. landing gear by placing the Landing Gear handle **(5)** in the UP position.
34		Maintain 12-14° AOA by smoothly nozzling out to 25° as quickly as aircraft performance will permit. Use the Velocity Vector as a visual reference above the horizon bars to help ensure a positive rate of climb.
35		At 25° nozzles and at least 120 KIAS, select AUTO Flaps by placing the Flaps switch in the AUTO position and finish smoothly moving the nozzles fully aft (0°).
35		Level off at 2000 feet AGL, reduce power, and seek to capture an airspeed of 250 KIAS. Select the NAV Master Mode button.

You are now ready to try first part of Training Mission 05 (CONVENTIONAL TAKEOFF AND BASIC HANDLING) included with the AV-8B Night Attack module.

12.6 VERTICAL TAKEOFF (VTO)

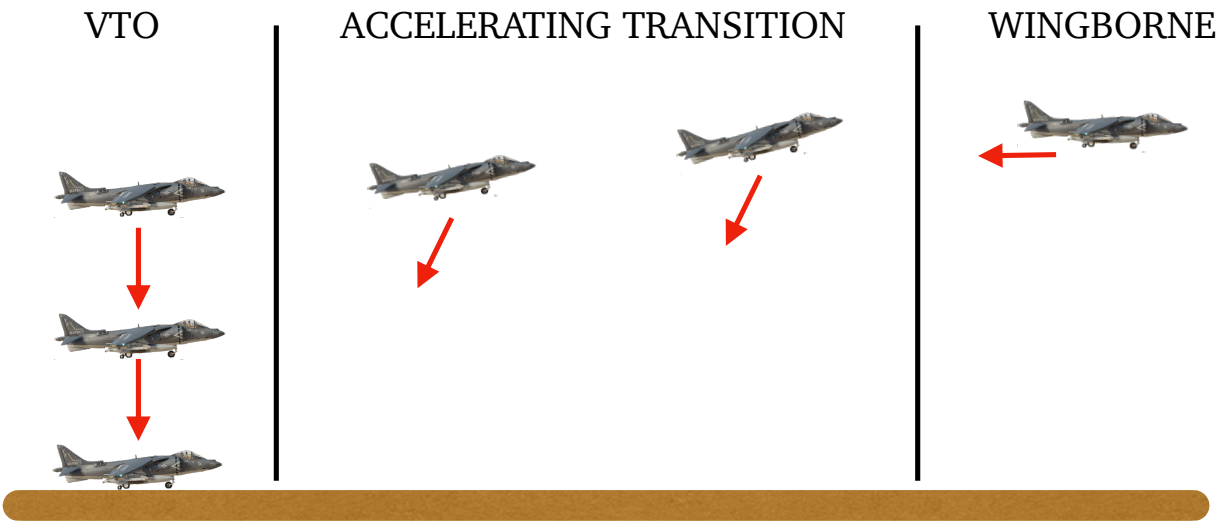
Vertical takeoff, alongside the vertical landing, is the one for which perhaps the AV-8B Harrier is most well known. It is also considered - at least by some - to be the easiest type of takeoff, there are a number of insidious flight characteristics that must be anticipated and accounted for.

Three golden rules pilots has to memorise for all VTOs:

1. Always takeoff into the wind.
2. Always takeoff from the flat terrain.
3. Do not exceed the maximum takeoff weight of 20 500 lbs.

VTO Basics

VTO is a type of jetborne takeoff, which is characterised by using the nozzles to enable the aircraft to get airborne vertically, without any forward movement. Just like STOs, all VTOs should end with an accelerating transition to wingborne flight.



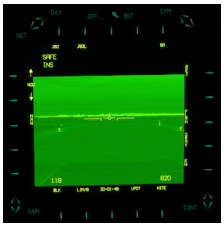
The red arrow shows the nozzle angle during all three phases of VTO.

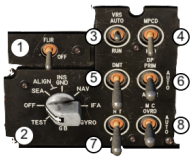
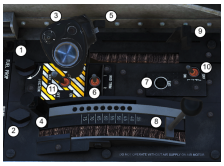
It is crucial to keep the aircraft level - scanning for roll is always the primary focus on liftoff. The pilot should immediately counteract any developing roll or bank angle, keeping the wings level, and scan left and right to ensure there is no sideways drift.

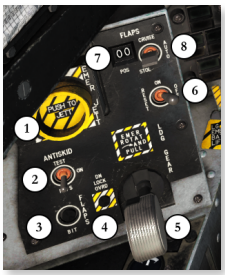
Once the aircraft reaches 50 feet (which is the usual hover altitude), you can begin the accelerating transition. To do so, the Witch's Hat should be put at the pitch carets while simultaneously nozzling out so that the nozzle angle with relation to the ground remains unchanged. Once established in wingborne flight, reduce power and complete the nozzle out to fully aft (or 0°).

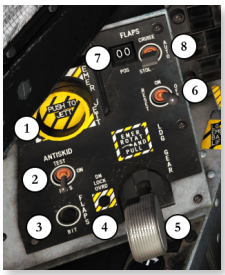
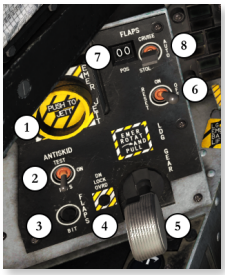
12.6.1 VERTICAL TAKEOFF PROCEDURE:

Following steps should be observed for proper conventional takeoff in the AV-8B N/A:

1		Set the Clock by pressing the Timer (TMR, **4**) button on the UFC. Select TTT with ODU-2 and then press ODU-1 and verify that the clock shows current time. Press ODU-5 and check that the UTC time shows 4 am. Verify that this is the same as the time shown on the cockpit watch and on the HUD.
2		Program your weapons via the UFC Weapons (WPN, **8 right**) button and ODU.
3		Set your FLIR by pressing MENU (P/B 18) and then FLIR (P/B1). Set the mode to Black or White by pressing pushbutton 20.
4		Set up your TACAN by pressing the TCN (**8**) button. Enter desired channel on your scratchpad and press ENTER. Next, turn it ON by pressing the ON / OFF button.
5		Set up your Video Recording System by setting your VRS and MFCD / HUD switches as desired.
6		Set your electronic countermeasures switches by performing a BIT and monitoring for failures. This isn't necessary on our FAM flight so we will skip it.

7		Set your Radar altimeter low altitude warning to desired value (usually 4900 feet). First press ALT button on your UFC. Next, colonise GPS with ODU button 3 and check that the Ground Proximity Warning System (GPWS) is colonised. Type "4900" and press ENTER.
8		Confirm that your canopy is locked and the canopy close light is extinguished.
9		Make sure that the ejection seat is armed by checking that the ground safety control handle on the right side of the seat is closed and pointing up.
16		Place your Altitude (ALT) switch **(6)** in the Radar (RDR) position.
17		Make sure that your INS knob **(2)** is in the IFA position to ensure a tightly coupled GPS and INS throughout your flight.
18		Turn your Approach light **(2)** ON.
19		Check the current aircraft weight by using the VREST page. On the right MPCD, select MENU (P/B 18). Next, select VREST (VRST) (P/B 8). OK, now box either Vertical Landing (VL) (P/B 6) or Vertical Take Off (VTO) (P/B 7). The aircraft weight is listed in the gross weight (GWT) readout at the bottom of the list.
19		Begin "one finger" checks by pressing the V/STOL Master Mode button to colonize the ODU with V/STOL options. Select Pitch Carets (PC) with ODU button 2 and verify a default setting of 14° in the scratchpad and confirm with ENT button.
21		Ensure the STO stop is clear and fully aft.

22		Trim the Stabilator **(4)** to 2° nose down.
23		Set Flaps to STOL, observe 25° in the Flaps Position indicator, and verify that no warning / caution / advisory lights are illuminated other than DROOP, which can be on.During the takeoff, you will have to maintain a nozzle angle of 25° or greater while in STOL flaps.
24		Select MENU on the right MPCD (P/B 18) and select Engine (ENG) (P/B 11). Set the nozzle lever to the STO stop and verify that the Engine Display Panel matches the HUD. Verify that the flaps adjust to 62° and that the Flaps Indicator matches the HUD with DROOP light illuminated. Reset the nozzle lever to 10°.
25		Request permission from tower to take off. When cleared, you may release the brakes and steer into the wind. Apply the brakes to come to a stop.
26		Box Acceleration (ACCEL) (P/B 16) on the Engine (ENG) page on your right MPCD. Hold the brakes and advance the throttle to just above 60%, then reduce power to maintain 60%. The aircraft will time how long it takes for the engine to spool between 35% and 60%. Verify that this value is between 2.4 and 3.1 seconds on the ENG page.
27		Arm the water switch to Takeoff (TO) and note the RPM rise by 6% to 7%. Reset the RPM to 60%
27		Next, place the nozzles at 30° and check the duct pressure. Once verified, set the nozzles for takeoff at the hover stop, or **82°**.

28		On the left MPCD, select EHSD with P/B 2 or Sensor Select Switch Left. On the right MPCD, select FLIR with Sensor Select Switch Right. Two-Finger Checks are complete.
		Keep the Anti-Skid Switch in the ON position.
29		Hold the brakes until you are airborne. You will initiate the takeoff by throttling up to full power in one smooth motion. Check your top end RPM and that you have positive water flow. Immediately counteract any developing roll or bank angle, keeping the wings level, and scan left and right to ensure there is no sideways drift.
30		As you pass 50 feet, set your accelerating attitude by placing the Witch's Hat at the pitch carets and begin nozzling out simultaneously, such that the nozzle angle with relation to the ground remains unchanged. You will center the windvane and V/STOL sideslip ball in the HUD (preferably by looking through the V/STOL ball at the windvane) using the rudder pedals prior to reaching 30 knots, and remain wings level while gradually reducing nozzle angle further.
31		Once established in wingborne flight, reduce power and complete the nozzle out to fully aft (or 0°). Maintain climbing flight and ensure the velocity vector does not descend below the horizon bars in the HUD. Seek to maintain between 12 and 14 units of AOA with the nozzle handle until established in wingborne flight.
32		Place your landing gear up, Ensure your flaps are in AUTO and Ensure you have nozzled out to fully aft (0°).

33		Set the Water switch to OFF.
35		Select the NAV Master Mode button.

12.7 LANDING

Unlike most aircraft type, that are capable of only one type of landing - the conventional one (be it through the overhead break or straight - in approach), AV-8B pilots can choose between several ways to get back on the ground. These are:

1. Conventional landing
2. Short landing (with three sub-categories)
3. Vertical landing (with two sub-categories)

This part of the manual will describe the techniques and procedures for each type of landing.

It is advised to practice each landing type by playing specific training missions dedicated to them. These are based on the information from the manual, with an advantage of more practical info added here and there.

12.7.1 LANDING CHECKLIST

There are two different checklists that should be followed before landing.

Before descent

Before descent checklist consists of six steps:

1. Check that the STO STOP is in the CLEAR position.
2. Check weather information by contacting the airfield you are about to land or by tuning to ATIS station. Pay special attention to the wind.
3. Set steerpoint to the airfield you are about to land at.
4. Set up the TACAN. See XXX section for more information.
5. Set the approach course, aligning the course arrow with the runway you are going to use.
6. Turn on the APU (during nights or bad weather landings the APU can serve as a backup generator if the main unit fails).

Before landing

Landing checklist contains six further steps:

1. Extend the landing gear.
2. Set flaps to AUTO.
3. Make sure that the STO STOP is clear.
4. Check the DUCT PRESSURE.
5. Check the BRAKE PRESSURE by pressing both TOE BRAKES.
6. Set the H_2O switch as required.

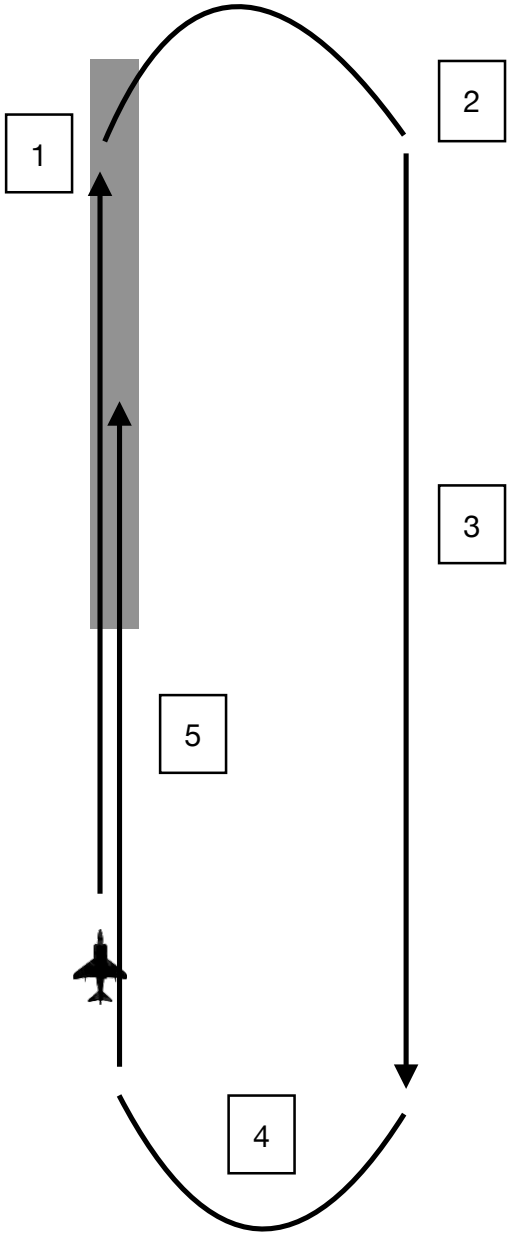
12.8 CONVENTIONAL LANDING (CL)

Just like the conventional takeoff, the conventional landing is not the most common way of getting back on the ground in the Harrier. In fact, combination of design characteristics make conventional landings more of a contingency procedure, generally only used if there is a suspected failure of the Reaction Control System (RCS).

Nevertheless, this section will describe the conventional landing procedures using the overhead break.

Conventional landing basics

After performing the before descent, pilot should fly the following pattern for a successful conventional landing:



1. Fly at 800 feet AGL, 350 IAS, turn as runway end disappears from view.

2. 4G level turn, intercept 10 units AoA, exit below 250 IAS.

3. Descend to 600 feet AGL, landing gear DOWN, flaps AUTO, brake pressure CHECK, water AS REQUIRED.

4. V/STOL Master Mode ON, Radar Alt ON, turn, keep 10-12 units AoA, descend to 200 ft AGL on Final.

5. At 50 feet AGL put Witch's Hat 2 degrees above horizon, control descent with throttle.

CL operating limits

When performing the conventional landing, always bear in mind the following limitations:

1. Maximum landing weight is 26 000 lbs.
2. Maximum speed for deploying landing gear is 250 knots.
3. Maximum speed on the ground is 180 knots.

Crosswinds for landing at 140+ and more:

4. Maximum crosswind for dry runway during the day is 20 knots.
5. Maximum crosswind for dry runway during the night is 15 knots.
6. Maximum crosswind for wet runway during the day is 15 knots.
7. Maximum crosswind for wet runway during the night is 10 knots.

Crosswinds for landing at below 140 knots:

8. Maximum crosswind for dry runway during the day is 15 knots.
9. Maximum crosswind for dry runway during the night is 10 knots.
10. Maximum crosswind for wet runway during the day is 10 knots.
11. Maximum crosswind for wet runway during the night is 5 knots.

If the gross weight of the aircraft exceeds 19 550 pounds, deduct 10 knots from the numbers listed above for crosswind.

12.9 SHORT LANDING

Short landing is probably the most commonly used way of getting back to the ground in the Harrier, especially when returning to base with remaining ordnance. It is also easier to perform than vertical landing.

There are two basic types of short landing:

Fixed Nozzle Slow Landing (FNSL) is the most common slow landing, used in most environments where maximum performance isn't necessary. It gets its name from the fact that the pilot sets the nozzles and doesn't adjust them until after touchdown.

Most FNSLs are performed with flaps set to STOL, because it is easy to perform, less costly in fuel than other types.

However, when crosswinds exceed 15 knots during the day or 10 knots during the night, an alternate version of FNSL can be chosen, with flaps set to AUTO. This type is also recommended for landings with high stores asymmetries.

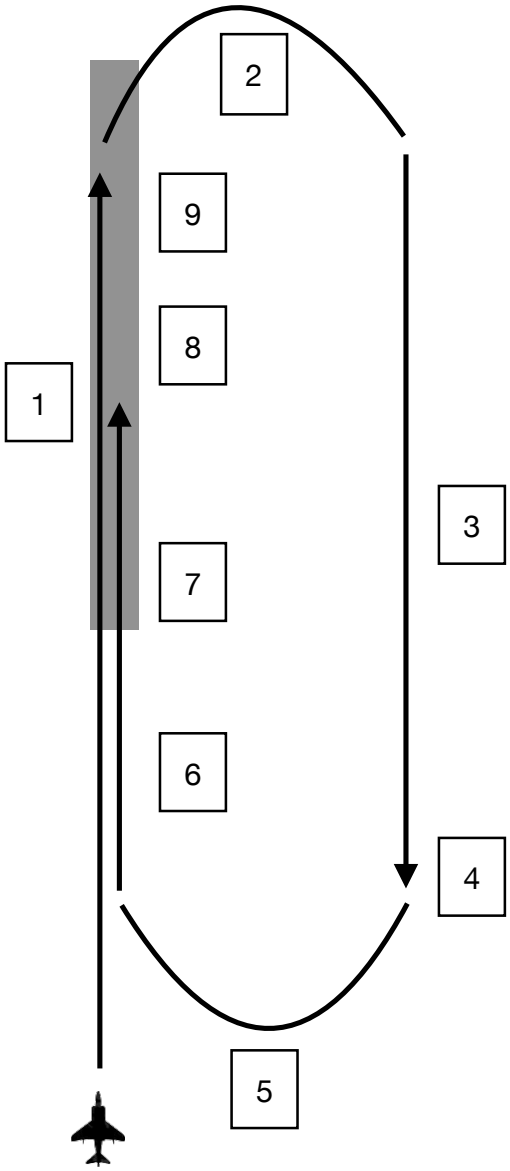
Variable Nozzle Slow Landing (VNSL) is less common, but provide maximum performance and wave-off margins, especially at high field elevations, in hot weather, or when bringing back a lot of ordnance. In this case, the pilot sets a specified power setting and performs slight "trial and error" variations of nozzle angles to maintain a steady, optimum angle of attack.

Again, the recommended VNSL is conducted with STOL Flaps, but requires a power setting high enough that the nozzles won't need to be set to less than 50°, so that the STOL Flaps do not raise inadvertently, but low enough that you will still have power available for a wave-off if necessary.

The alternate version is conducted with AUTO Flaps, and is used for VNSL RPM settings below 90% or in the event of an emergency such as a stuck throttle below 90% or an "OIL" caution.

12.9.1 STOL FLAPS FIXED NOZZLE SLOW LANDING

As it was stated above, the Fixed Nozzle Slow Landing is the recommended slow landing technique, used when maximum performance is not necessary and allowing pilot to save fuel.



1. **Arrive over the runway** at 800 feet and 350 KIAS.

2. **Once the runway disappears from view** below the nose of your aircraft, execute a level turn, in which you will capture 4G in the beginning and then intercept and keep 10 units of angle of attack (AoA). Reduce the throttle. Hold that turn for 180° until you are flying parallel to the runway.

3. On **downwind leg**, keep below 250 KIAS, perform landing checklist: lower the landing gear, set flaps to STOL mode; check that the STO Stop is clear and stowed aft; check for positive duct pressure; check that brake pressure is 2700 PSI with pedals depressed; make sure that the water switch is set as required for landing performance.

4. **Approaching the 180** at 1.3 to 1.5 NM abeam, around half the length of the runway beyond its starting point, set the nozzles to 60° and double check that your Flaps are in STOL. Switch to the radar altimeter by entering the V/STOL HUD master mode.

5. **At the 180**, begin your turn towards the runway. Control descent with the stick and seek roughly a 5° glide path through the first half of the turn to "the 90" and a 3° glide path past "the 90", with a rate of descent between 1000 and 1500 feet per minute. You are targeting between 500 and 600 feet AGL at the 90 and between 200 and 225 feet AGL for the roll out on final ("in the groove").

6. **On final**, you may require a power reduction to remain "on speed" between 10 and 12 units of AOA. Ensure you are maintaining coordinated flight with your rudder. Maintain a 3° glide path. At 50 feet AGL assume landing attitude by placing the Witch's Hat 2° above the horizon, continue to control rate of descent with the throttle and attitude with the stick, with a rate of descent between 200 and 400 feet per minute.

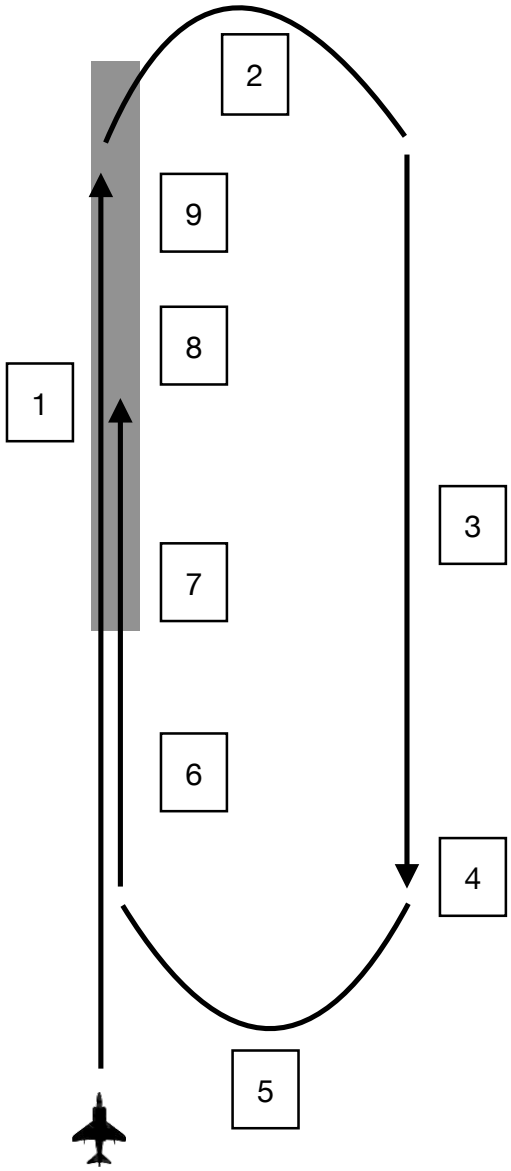
7. **At touchdown**, set the throttle to idle and make sure that you are rolling straight with the pedals neutralised before engaging Nose Wheel Steering (NWS). Set the nozzles to 98° for power nozzle braking (PNB), trim for 2° nose down, and set the throttle no higher than 70% to slow the aircraft.

8. **As the aircraft slows below 60 knots** ground speed, bring the throttle back to idle, place the nozzles to the hover stop, and use wheelbrakes to finish slowing the aircraft.

9. **At taxi speed** set the water switch to OFF, and bring the nozzles to 60°, and then set them to 10°.

12.9.2. AUTO FLAPS FIXED NOZZLE SLOW LANDING

Auto flaps Fixed Nozzle Slow Landing is used during high crosswinds, or when high stores asymmetry is present. This landing requires higher approach speed and landing rollout. For reference, differences between STOL flaps landing will be marked in blue.



1. **Arrive over the runway** at 800 feet and 350 KIAS.

2. **Once the runway disappears from view** below the nose of your aircraft, execute a level turn, in which you will capture 4G in the beginning and then intercept and keep 10 units of angle of attack (AoA). Reduce the throttle. Hold that turn for 180° until you are flying parallel to the runway.

3. On **downwind leg**, keep below 250 KIAS, perform landing checklist: lower the landing gear, set flaps to AUTO mode; check that the STO Stop is clear and stowed aft; check for positive duct pressure; check that brake pressure is 2700 PSI with pedals depressed; make sure that the water switch is set as required for landing performance.

4. **Approaching the 180** at 1.3 to 1.5 NM abeam, around half the length of the runway beyond its starting point, set the nozzles to 60° and double check that your Flaps are in AUTO. Switch to the radar altimeter by entering the V/STOL HUD master mode.

5. **At the 180**, begin your turn towards the runway. Control descent with the stick and seek roughly a 5° glide path through the first half of the turn to "the 90" and a 3° glide path past "the 90", with a rate of descent between 1000 and 1500 feet per minute. You are targeting between 500 and 600 feet AGL at the 90 and between 200 and 225 feet AGL for the roll out on final ("in the groove").

6. **On final**, you may require a power reduction to remain "on speed" between 10 and 12 units of AOA. Ensure you are maintaining coordinated flight with your rudder. Maintain a 3° glide path and fly a crabbed approach to ensure your aircraft is lined up on centerline. At around 50 feet AGL assume landing attitude by placing the Witch's Hat at 2° above the horizon, continue to control your rate of descent with your throttle and attitude with the stick, with a rate of descent between 200 and 400 feet per minute.

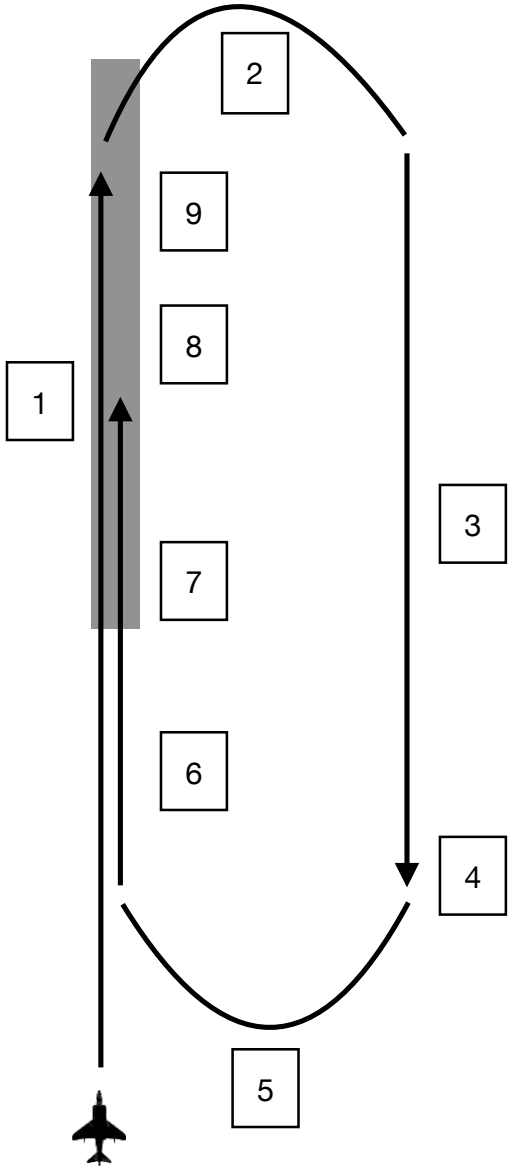
7. **At touchdown**, set the throttle to idle and make sure that you are rolling straight with the pedals neutralised before engaging Nose Wheel Steering (NWS). Set the nozzles to 98° for power nozzle braking (PNB), trim for 2° nose down, and set the throttle no higher than 70% to slow the aircraft.

8. **As the aircraft slows below 60 knots** ground speed, bring the throttle back to idle, place the nozzles to the hover stop, and use wheelbrakes to finish slowing the aircraft.

9. **At taxi speed** set the water switch to OFF, and bring the nozzles to 60°, and then set them to 10°.

12.9.3 STOL FLAPS VARIABLE NOZZLE SLOW LANDING

This type of landing provides maximum performance and wave off margins, and therefore it is recommended when landing at high field elevations, during very hot weather or with heavy ordnance load.



1. **Arrive over the runway** at 800 feet and 350 KIAS.

2. **Once the runway disappears from view** below the nose of your aircraft, execute a level turn, in which you will capture 4G in the beginning and then intercept and keep 10 units of angle of attack (AoA). Reduce the throttle. Hold that turn for 180° until you are flying parallel to the runway.

3. On **downwind leg**, keep below 250 KIAS, perform landing checklist: lower the landing gear, set flaps to STOL mode; check that the STO Stop is clear and stowed aft; check for positive duct pressure; check that brake pressure is 2700 PSI with pedals depressed; make sure that the water switch is set as required for landing performance.

4. **Approaching the 180** at 1.3 to 1.5 NM abeam, around half the length of the runway beyond its starting point, set your throttle between 90 and 100%, initially set the nozzles between 50° and 60°, and double check that your Flaps are in STOL. Switch to the radar altimeter by entering the V/STOL HUD master mode.

5. **At the 180**, Control your descent with the stick and place the Witch's Hat 5° nose down. Wait for your AOA to settle and adjust your nozzles to control AOA. If AOA is low, increase nozzle angle slightly. If AOA is high, decrease nozzle angle slightly. Avoid overshooting the target AOA by anticipating the nozzle movement and adjusting nozzle angle to capture 8 to 10 units AOA. You are targeting between 500 and 600 feet AGL at the 90 and between 200 and 225 feet AGL when you roll out on final ("in the groove").

6. **On final**, you may require a power reduction to remain "on speed" between 10 and 12 units of AOA. Ensure you are maintaining coordinated flight with your rudder. Maintain a 3° glide path and fly a crabbed approach to ensure your aircraft is lined up on centerline. Avoid getting too slow and nozzling below 50° in STOL Flaps. Doing so will cause the flaps to begin programming less than full, resulting in a potentially hazardous loss of lift and AOA increase. As you pass through 100 feet AGL, you may begin controlling your rate of descent with your

throttle. At around 50 feet AGL assume landing attitude by placing the Witch's Hat at 2° above the horizon, continue to control your rate of descent with your throttle and attitude with the stick, with a rate of descent between 200 and 400 feet per minute.

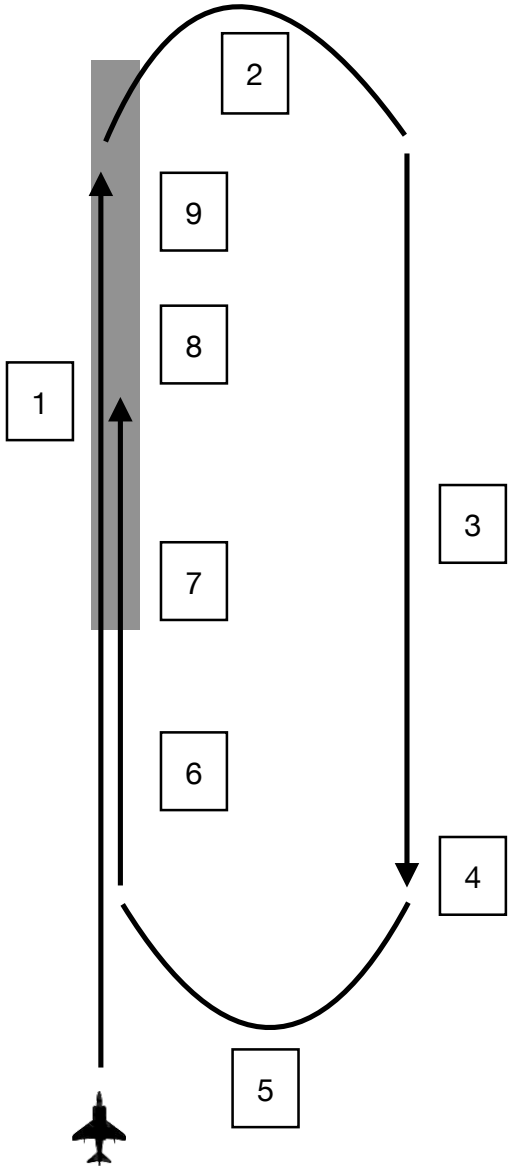
7. **At touchdown**, set the throttle to idle and make sure that you are rolling straight with the pedals neutralised before engaging Nose Wheel Steering (NWS). Set the nozzles to 98° for power nozzle braking (PNB), trim for 2° nose down, and set the throttle no higher than 70% to slow the aircraft.

8. **As the aircraft slows below 60 knots** ground speed, bring the throttle back to idle, place the nozzles to the hover stop, and use wheelbrakes to finish slowing the aircraft.

9. **At taxi speed** set the water switch to OFF, and bring the nozzles to 60°, and then set them to 10°.

12.9.4 AUTO FLAPS VARIABLE NOZZLE SLOW LANDING

This landing type is very rarely used and mostly in an emergency, notably when RPM setting is below 90% for any reason or during "OIL" caution. For reference, differences between STOL flaps landing will be marked in blue.



1. **Arrive over the runway** at 800 feet and 350 KIAS.

2. **Once the runway disappears from view** below the nose of your aircraft, execute a level turn, in which you will capture 4G in the beginning and then intercept and keep 10 units of angle of attack (AoA). Reduce the throttle. Hold that turn for 180° until you are flying parallel to the runway.

3. On **downwind leg**, keep below 250 KIAS, perform landing checklist: lower the landing gear, set flaps to STOL mode; check that the STO Stop is clear and stowed aft; check for positive duct pressure; check that brake pressure is 2700 PSI with pedals depressed; make sure that the water switch is set as required for landing performance.

4. **Approaching the 180** at 1.3 to 1.5 NM abeam, around half the length of the runway beyond its starting point, set your throttle between 80 and 90%, initially set the nozzles between 40° and 50°, and double check that your Flaps are in AUTO. Switch to the radar altimeter by entering the V/STOL HUD master mode.

5. **At the 180**, Control your descent with the stick and place the Witch's Hat 5° nose down. Wait for your AOA to settle and adjust your nozzles to control AOA. If AOA is low, increase nozzle angle slightly. If AOA is high, decrease nozzle angle slightly. Avoid overshooting the target AOA by anticipating the nozzle movement and adjusting nozzle angle to capture 8 to 10 units AOA. You are targeting between 500 and 600 feet AGL at the 90 and between 200 and 225 feet AGL when you roll out on final ("in the groove").

6. **On final**, you may require a power reduction to remain "on speed" between 10 and 12 units of AOA. Ensure you are maintaining coordinated flight with your rudder. Maintain a 3° glide path and fly a crabbed approach to ensure your aircraft is lined up on centerline. At around 50 feet AGL assume landing attitude by placing the Witch's Hat at 2° above the horizon, continue to control your rate of descent with your throttle and attitude with the stick, with a rate of descent between 200 and 400 feet per minute.

7. **At touchdown**, set the throttle to idle and make sure that you are rolling straight with the pedals neutralised before engaging Nose Wheel Steering (NWS). Set the nozzles to 98° for power nozzle braking (PNB), trim for 2° nose down, and set the throttle no higher than 70% to slow the aircraft.

8. **As the aircraft slows below 60 knots** ground speed, bring the throttle back to idle, place the nozzles to the hover stop, and use wheelbrakes to finish slowing the aircraft.

9. **At taxi speed** set the water switch to OFF, and bring the nozzles to 60°, and then set them to 10°.

12.10 VERTICAL LANDING (VL)

It is important to bear in mind that this is a kind of landing the Harrier was designed to perform. The geometry of its landing configuration is thus arranged to optimize vertical landing control and reference.

VLs are the only types of landings allowed on the boat and will be regularly performed on deployments - but as they require different procedures, will be described in a different chapters. Some of the FARPs will also only be accessible via a VL.

This type of getting back on the ground may seem daunting at first, but with some practice it will become a second nature of any Harrier pilot.

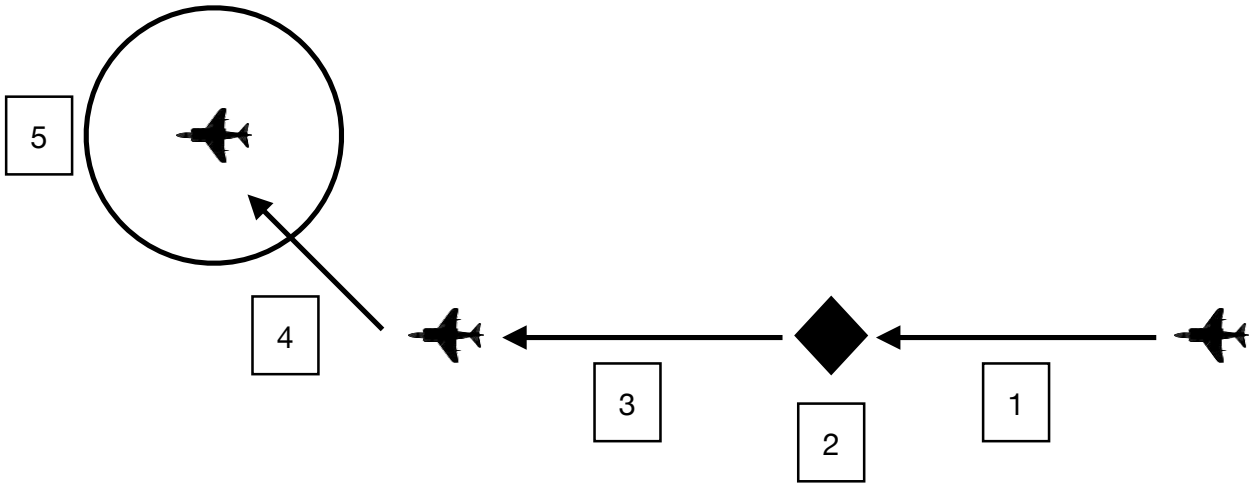
The three golden rules for the VLs are the same as for the takeoff:

1. Always land into the wind.
2. Always land on the flat terrain.
3. Do not exceed the maximum landing weight of 20 500 lbs.

Vertical landing basics

The full procedure of the vertical landing is as follows:

1. Perform the Before Landing checklist and then aim to arrive at the Key, which is located approximately half a nautical mile (3500 feet) from the designated landing spot, at an altitude of approximately 325 feet AGL. On the way, keep the nozzles at 60° and keep the AOA between 10 and 12 units.
2. At the Key, set a correct attitude by placing the Witch's Hat on the horizon and moving the nozzles to Hover Stop position (81-83°) and use a Decelerating Transition to switch from wingborne flight to jetborne flight.
3. After that you will maintain a shallow glideslope of 3 degrees to arrive over and slightly offset, or abeam the landing site.
4. Then, maintaining altitude of at least 150 feet AGL and speed below 30 knots, you will cross over to the landing site and enter hover.
5. Finally, you will commence the Vertical Landing from the hover at around 50 feet AGL.



12.10.1 VERTICAL LANDING CHECKLIST

The vertical landing checklist slightly differs from the standard one described before and consists of the following steps:

1. Extend the landing gear below 250 knots.
2. Enter V/STOL Master Mode.
3. Make sure that your nozzles are set to 25 degrees or more and set the flaps to STOL mode.
4. Check that the STO Stop is clear.
5. Check the DUCT PRESSURE.
6. Check the BRAKE PRESSURE by pressing both TOE BRAKES.
7. Set the H_2O switch to landing (LDG) as required.
8. Set your Video Recording System to RUN.
9. Check that there are no warning or caution lights illuminated.
10. Set the lights as required. Standard operation procedures require you to enable your position lights, anti-collision lights and landing lights.

It goes without saying that for the vertical landing you will need your Radar Altimeter turned on and working. As a backup measure, remember to set up your Barometric Altimeter pressure to match the conditions of the landing site.

12.10.2 AT THE KEY / DECELERATING TRANSITION

1. On the way, keep the nozzles at 60° and keep the AOA between 10 and 12 units. Make sure to arrive at the Key at exactly 325 feet AGL.

2. The Key is located 0.5 Nm from the designated landing spot and can be marked for the pilot by the ground units with the use of smoke, determined using the portable TACAN station placed on the landing site or just judged by the pilot if no other means are available.

Over the Key keep the wings level and place the nozzles in Hover Stop. Check that the nozzle angle is between 81 and 83° and that flaps have programmed to 62°. Maintain AOA below 15 units.

3. Place the Witch's Hat on the horizon and use your throttle to maintain the shallow glideslope of 3°. Aim the aircraft for a position 150 feet AGL above the pad and slightly offset to one side. This will allow you to keep good sight of it.

At 60 knots, with the velocity vector on the horizon and wings level, you should see no more than 2 legs of the power hexagon, although this may not guarantee performance enough for hover and landing depending on environmental factors. If you see more than 2 legs, you are too heavy for your power available. Initiate a waveoff with full power, perform an accelerating transition, and reset at the Key.

If your speed falls below 50 knots a large power addition may be needed due to the loss of wing lift.

4. When the pad is on a 45° bearing from you, begin your cross to the pad by lowering your wing in its direction.

Control closure to the pad to less than 30 knots by making small pitch adjustments and keep the vane centered using the rudder. Trim the aircraft as necessary to minimize your workload!

When you are directly over it, flare slightly to stop and establish a stabilized hover.

When you are ready, reduce power slightly and descend to 50 feet AGL in a stabilized hover.

5. Once you are in a stabilized hover at 50 feet AGL over the landing point, you may initiate a vertical landing by reducing power slightly by 1-2% and establish a rate of descent between 300-400 feet per minute.

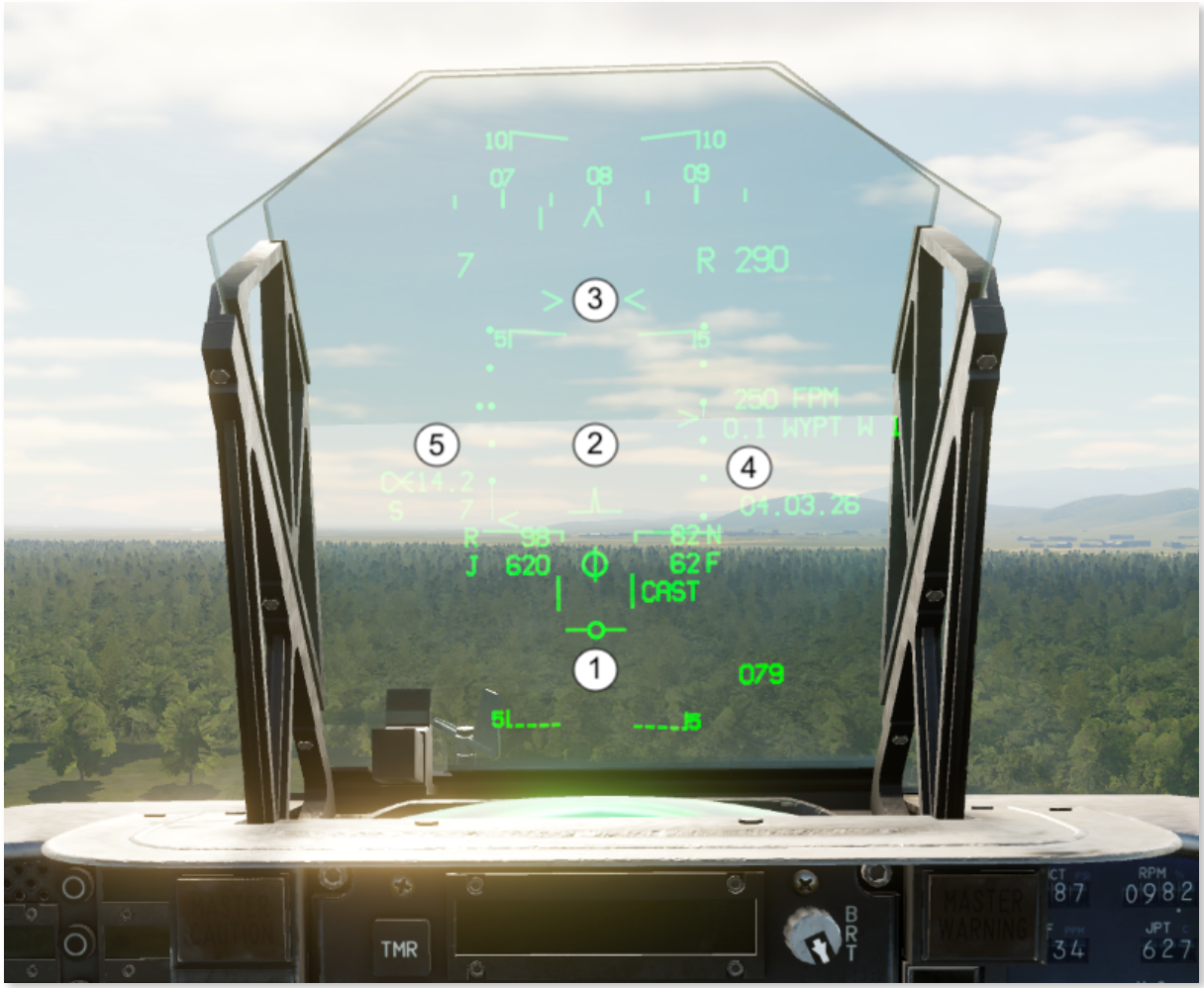
You may need to re-add throttle to capture this rate of descent, and reduce throttle as you enter ground effect (5-10 feet AGL).

Vertical landing tips

- Remember that the pitch control will be very sensitive and will require fine inputs and corrections.
- Roll control is even more important and any oscillations should be quickly corrected. It is imperative to keep to wings level unless you want to initiate a lateral translation of the aircraft.
- Pay constant attention to the yaw and govern it with the rudder.
- Maintain constant scan of the surroundings in order to maintain a reasonably fixed position over the landing site. There is absolutely no reason to be looking through the HUD for anything but RPM, JPT Ball, windvane and Velocity Vector. The best compromise scan is to look at some object to the side at an angle less than 90° left or right, about 20 to 30° down, and within about 100 to 200 feet of the aircraft (depending on hover height).
- Practice, practice, practice!

HUD Vertical landing aids

While this is true that during the VL pilot is required to keep a constant scan outside the pit, HUD does contain a number of very useful references which should often be consulted:



1. TVV. During VL it shows whether the aircraft is climbing or descending and by what amount. The higher it is above the horizon line, the fastest the climb and vice versa - the lower it gets, the quicker the descend. It is generally good to have the TVV inside the HUD FOV at all times to maintan control.

2. Witch's Hat. It shows where the nose of the Harrier is pointing at any given moment. Therefore keeping it on the horizon line means that the aircraft is in in perfect position for landing.

3. Pitch carets. Just like TVV is used to show the rate of climb or descend, the pitch carets move up and down indicating the forward or backward speed of the aircraft.

4. Digital climb rate and climb / descend scale. Both should help the pilot to quickly determine if the aircraft is climbing or descending and by what amount.

5. Speed scale. A small caret on the right side of the scale shows the forward or backward movement of the aircraft and its magnitude. It sometimes is difficult to read and should be treated as additional aid, with the digital speed readout and Pitch carets being used as the main ones.

12.10.3 AFTER LANDING CHECKLIST

When you touchdown:

1. bring the throttle to IDLE,
2. apply the brakes
3. set the nozzles fully aft
4. turn the water switch off
5. trim the nose to 4° nose down.

Rolling vertical landing (RVL)

RVL is performed in the same way as normal VL, however a small forward speed is maintained during the maneuver. RVL landing weight can be up to 4000 lbs higher than for the VL due to some wing lift developed thanks to the speed.

RVL requires even better scan of the surroundings and less HUD - focus than the normal VL. Pilot should should look outside to sense the rate-of descent and closure on the target spot. Looking through the narrow FOV of the HUD restricts his view and channels his concentration on too small a set of references.

12.11 FORWARD OPERATING BASE

Basing flexibility is a cornerstone of V/STOL (or more accurately STOVL) operations. Carrying tactical loads, STOVL aircraft can launch from unimproved surfaces of 1500 feet or less, requiring no external arresting or launching devices. STOVL also offers carrier independence and the opportunity for collocation with ground combat elements to enhance cooperative support and direct involvement in ground combat operations planning. Dispersed forward bases are also less susceptible to enemy attack on known, fixed locations such as air traffic control towers, communications facilities, and improved runways. Lastly, and likely most importantly, forward basing decreases the response time of tactical aircraft through the advantages of ground loiter and an increased sortie rate.

FOB operations can be extremely challenging and dangerous, and therefore it is crucial to practice them as often as possible in different types of bases and under various conditions.

FOB operations are not that different from normal procedures described in the earlier parts of this chapter.

However, for improvised runways, it is crucial to correctly use the VREST page and introduce all the necessary data for determining the nozzle rotation speeds and abort criteria.

Taxiing

For FOB operations you will always want to taxi with flaps in CRUISE mode, 5 degree nozzle angle and full nose-down trim, with a maximum of 15 knots ground speed.

Due to restricted spaces, you may need to use the HI-GAIN mode of the NWS. When maneuvering under such conditions, do not exceed 3 knots ground speed in order to achieve a minimum radius turn.

Takeoff

Both Vertical and Short Takeoffs are common for FOBs. The procedures for these do not differ from what was described earlier.

Landing

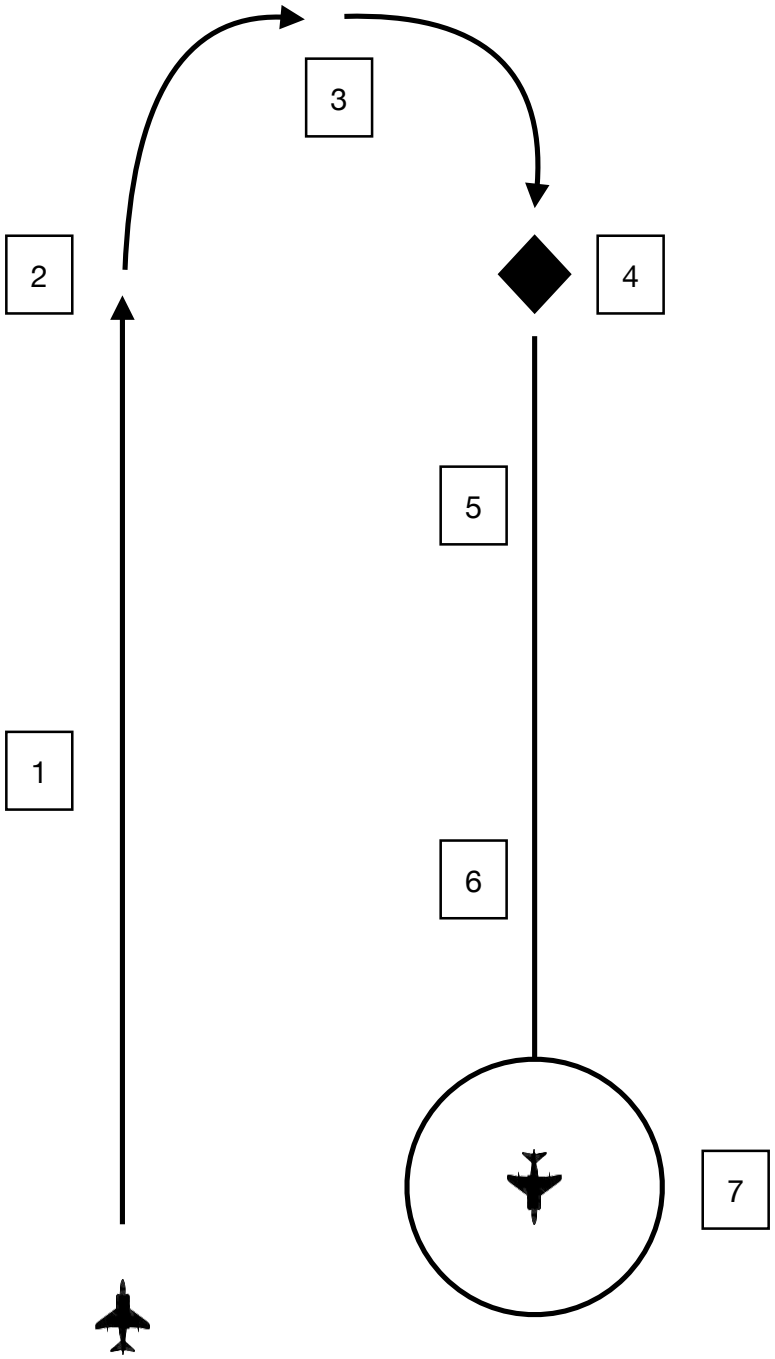
Depending on the type of the FOB, you will most likely perform a Fixed Nozzle Short Landing (FNSL), Precision Rolling Vertical Landing (RVL described below) or a normal Vertical Landing (VL).

Before the first landing at the given location, it is advised to overfly the destination before attempting to land in order to assess the situation and conditions. The area around smaller air facilities or air sites is not normally as clear as that of a main base or airfield, which means the approach end of a landing runway may be obscured from view by trees or terrain. The recommended overflight is made at 250 knots, 800 feet AGL, into the wind, and offset from the landing zone for ease of observation.

It is also a good habit to either create a new waypoint using the coordinates of the intended landing site or - if such coordinates are not available - to mark it while performing the overfly and later use it to set the desired landing heading / course line.

Precision Rolling Vertical Landing

This is a sub-type of a RVL specially adapted to conditions pilots may encounter at the FOBs.



1. Enter the downwind leg flying at 600 feet AGL between 0.8 - 1.0 NM from the runway. Complete the following landing checklist:

A. Extend the landing gear.

B. Set flaps to AUTO.

C. Make sure that the STO STOP is clear.

D. Check the DUCT PRESSURE.

E. Check the BRAKE PRESSURE by pressing both TOE BRAKES.

F. Set the H2O switch as required.

G. Set nozzles to 60 degrees.

H. Set ALTIMETER to RADAR.

2. When passing the KEY, turn towards the runway.

3. When passing the 90 degrees, arrive at 450 feet AGL

4. Arrive at the key at 325 feet AGL

5. Use nozzles to set the speed of 60 knots, fly level until 4 degree mark on pitch ladder is over the desired landing spot.

6. Begin to descend, keep the speed of 60 knots, aim at the middle of the intended landing spot. Watch for any obstacles.

7. After landing: set power to idle, apply brakes, nose trim 4 degree ND, nozzles to 10 degrees, H2O to off.