BK 117 B-2
ROTORCRAFT SIMULATION FLIGHT MANUAL

Valid for Model:	**BK 117 B-2**
Simulator Version:	**X-Plane® 9.40**
Serial No.:	**NDBK17**
Year of Manufacture:	**2009**
Manufacturer:	**ND Art & Technology**

THIS MANUAL MUST BE CARRIED IN THE HELICOPTER AT ALL TIMES

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FOR ENTERTAINMENT PURPOSES ONLY - DON'T USE FOR ACTUAL FLIGHT!

MANUAL CONTENT

INTRODUCTION

Thank you for purchasing the BK 117 B-2 for X-Plane and supporting my efforts to produce high quality aircraft for X-Plane!

To create this addon for X-plane has been a project driven by my fascination over the BK117 helicopter and the hundreds of life saving missions flown by it and it's crews every day around the world for 30 years. But it has also been a project driven in an attempt to raise the bar and deliver a new level of realism for X-Plane aircraft addons.

Few, if any, aircraft for X-Plane have previously been modeled and simulated to the degree of detail you'll find in this helicopter. This is reflected in the many advanced systems that have been created specifically to allow the desktop pilot to come as close as virtually possible to operating a complex, twin engine medium IFR certified helicopter.

Detailed systems aside, the BK 117 is also capable of being the addon you want it to be. Start her cold and dark and you can perform a realistic start-up, following every item on the 4 page checklist, perform a CAT A takeoff and navigate to your destination in IFR conditions using the realistic autopilot and flight director functions. Or you can start her hot with all systems running and go flying directly, without flipping a single switch, in one of the most responsive and fun helicopters there is to fly. Thanks to custom modeled stability augmentation systems, the BK117 is a stable IFR platform that is easier to fly and more forgiving to the beginner than most helicopters.

Nils Danielsson, ND Art & Technology

Credits

Countless people have encouraged and helped make this project possible. At the risk of leaving someone out, however, I'd like to direct special thanks to the following contributors:

Brett Sumpter - helped tweaking performance and flying characteristics and many other things

Carmine Bevilacqua - real life doctor and BK 117 crew member who helped with photos, detailed information on operations and cockpit functions, handling characteristics and with involving real BK 117 pilots in test flying this addon.

"MUPP" - helped with documentation, big time.

Sandy Barbour - ported and optimized custom systems scripts to working FAT plugin. Also the man behind Pythoninterface which got me started with the X-Plane SDK in the first place.

"Propsman" - who keeps inspiring and raising the bar for state-of-the-art X-Plane aircraft in general and helicopters in particular.

Legal Notice

Re-paints

The owner of this product permits the user to distribute liveries and paints created using the included Paintkit. This permission does not apply to textures or other files that were included in the original package.

INSTALLATION AND SETUP

Installation

First of all, make sure you have version **9.40** or later of X-Plane installed.

Since X-Plane can change considerably with new versions, ND Art & Technology cannot guarantee that all aspects of the BK 117 will work on future versions of X-Plane. It's therefor a general recommendation that you always keep an older version of X-plane on your hard drive as backup before downloading and trying the BK 117 on newer versions of the sim.

To install the BK 117 addon, simply copy the full contents of the downloaded zip file to the desired folder within your X-plane/aircrafts folder. For instance, like this:

X-Plane 940\Aircraft\Helicopters\BK117

Plugin check

A plug-in is delivered with this add-on for X-Plane to enable realistic simulation and visual effects.

IMPORTANT!

To make sure the plugin is working correctly, make sure that a translucent box and a confirmation message is displayed after the BK 117 is loaded!

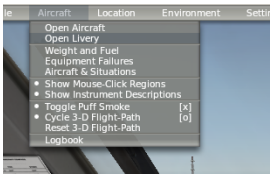
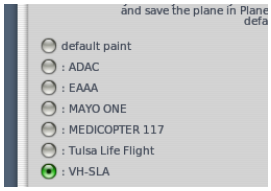
As always, you can chose if you wish to start with systems and engines running, or if you want to perform a realistic startup from a dark and cold helicopter. The plugin will sense your settings and initialize all custom systems accordingly.

Configurations and liveries

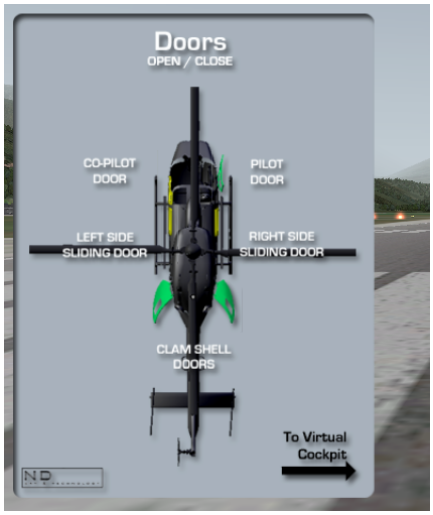
You can choose from two configurations of the BK 117 when loading the aircraft.

BK-117.acf	Clean configuration with only settling protectors installed
BK-117+RAD+WP.acf	Weather radar radome and wire protection kit installed

The BK 117 also comes with a number of liveries, representing actual aircraft operating in various parts of the world.

Select Open Livery from the Aircraft drop down menu.	
Double click on the bullet next to the livery you wish to load.	
Enjoy the new appearance of your aircraft!	

Crew and doors

You can open and close all **doors** on the helicopter by going to the 2D panel forward view (w) and click on the door symbols. Yellow indicates a closed door, green indicates an open. 	You can add or remove crew members and patient in the Weight & Balance & Fuel menu, Ordnance tab. Changing the occupants of the helicopter will accurately impact the weight and center of gravity, as well as visual appearance.  

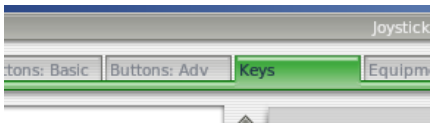
Assigning custom commands

Many of the custom systems simulated for the BK 117 can be assigned to key commands or joystick buttons. *Which commands do what is described in the System Description section of this manual.*

To assign a custom command, go into X-Plane's Joystick & Equipment menu ...

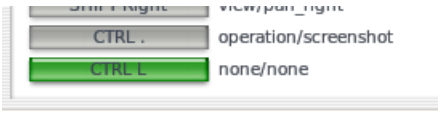
... and select a Buttons or Keys tab depending on whether you want to use a joystick button or a keyboard key to control a command.

In this example, I want to assign a keyboard key. The process for assigning joystick buttons however is very similar.

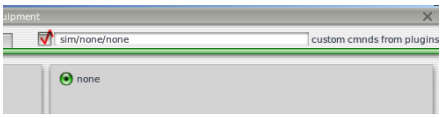


In the Keys menu, click Add New Key Assignment.

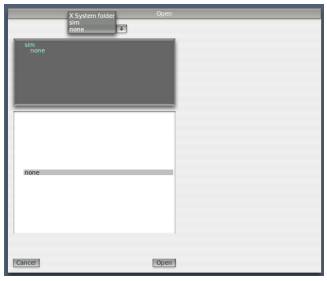
Next, click on the empty slot that shows up on the left and then press the key or key combination that you wish to assign to. In this example, I want to assign CTRL + L.



Then, in the upper right corner, click the grey check box.



A folder dialog will open. Click the  button and then select the **X System folder**.



You should now see at least these two folders. Double click on the bk117 folder.

These two folders will show. Double click the appropriate one depending on what kind of system command you wish to assign.

In this example, I want to assign the **Flight Director Standby** so I choose the **autopilot** folder.

I then double click the **fd_stby** command to load it.

The result: **CTRL+L is assigned to the Flight Director Standby command!**

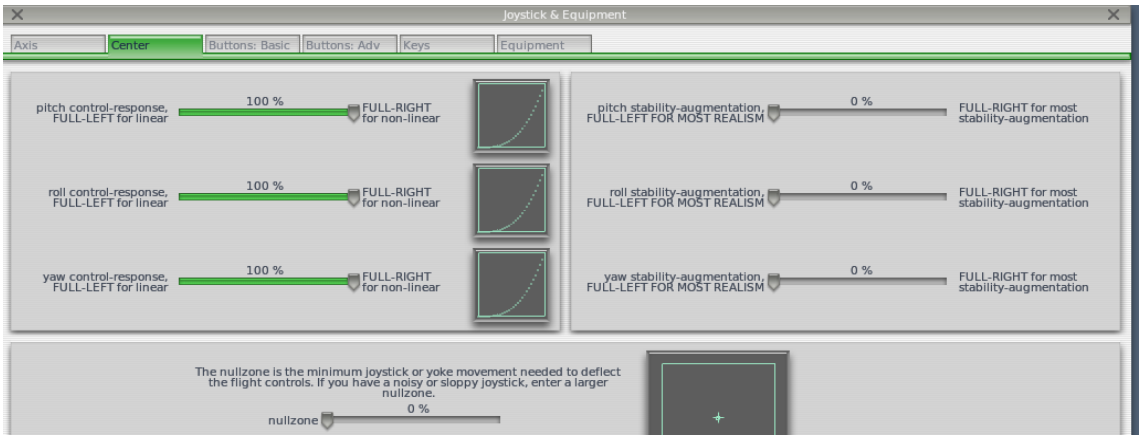
Tips and setup

Control settings

Helicopters can be hard to control in X-Plane because real helicopters have much bigger controls with a lot more control travel. While your typical gaming joystick might have 5 inches of travel, a real helicopter cyclic stick might have 3-4 times that.

The best cure to this, besides buying expensive real sized controls, is to use non-linear control sensitivity. This means that around the center, your joystick will give less control input per travel. Combined with sensible use of cyclic **trim**, using non-linear controls will allow you to maneuver the BK 117 helicopter with good accuracy in all parts of the flight envelope.

Set the controls to **non-linear** in the Joystick & Equipment menu. Also make sure your **realism settings** (bars on the right) are set to full realism/full left. It's also recommended that you use a zero **null zone**.



Command assignments

The custom commands available with this addon are optional. To get the most realistic BK 117 flying experience, however, it's recommended that you at least set up the following commands:

Command	Recommended assignment
Force trim release	Joystick button
Beep trim (fwd, aft, left, right)	Joystick four-way switch
Autopilot attitude mode (att_mode)	Keyboard, e.g. CTRL+A
Couple Flight Director	Keyboard, e.g. CTRL+C

Using a 3D Cockpit

For tips and information on how best set yourself up for flying with a 3D cockpit, such as that in the BK 117, follow this link to the x-plane.org tips on flying in a 3D cockpit

Flying helicopters

For tips on how to fly helicopters in general, it's recommendable that you head over to x-plane.org's helicopter flight school

FAQ

If you are having difficulties, you can always visit the x-plane.org BK 117 support forum

Q:	**A:**
After I've crashed with the helicopter, the **plugin doesn't seem to work** anymore.	Delete your preferences files, located in: your x-plane folder\output\preferences and restart X-Plane.
Some of the **instruments on the co-pilot side** of the cockpit does not seem to work.	Some of the co-pilot's instruments have been consciously left non-functional to allow the BK 117 to run smoother on old computers.
Some of the **flight director modes** are not working.	VOR APR and GA modes are not supported by X-Plane but do not have a great effect on the realistic operation of the helicopter.
When flying slow and descending, **the helicopter abruptly looses altitude and crashes.**	X-Planes simulation of transition in and out of translational lift is exhaggerated, sometimes causing a violent "dip" in lift. To avoid this causing a crash, make sure you never exceed a descent rate of 300 ft/min when flying below 25 knots IAS.
I can't take-off / I can't control the helicopter.	Make sure you have unlocked the collective and cyclic stick before attempting to fly!
How do I use the autopilot to fly to a certain heading and altitude.	1. Select ATT mode on the autopilot panel. 2. Rotate the heading bug to the desired heading. 3. Select HDG and the desired vertical mode (IAS or VS) on the FD mode selector. CPL button should illuminate on the AP panel. 4. Adjust IAS or vertical speed with beep trim switch as required. Adjust collective as required. 5. Dial desired target altitude on the air data display and click on the ALT FD mode button within 15 seconds. ALT ARM should illuminate in amber.
It's hard to see over the nose when coming in to land.	This is also true for the real aircraft. Apply left pedal and place the aircraft in a side slip. Keep the landing zone visible in the lower right corner of the front windscreen.
After loading a new location or airport, the **engines are turned off.**	This is an X-Plane limitation, causing the plugin not to initialize correctly. Be quick in placing the engine control levers in FLY (press F2) or simply reload the helicopter to initialize all systems properly.

GENERAL

The BK 117 is an eight-seat, twin engined medium utility multi-role helicopter, utilizing a four-bladed hinge less main rotor system with fibre-reinforced composite blades, and a semi-rigid, two-bladed tail rotor.

Development was a joint effort by German Messerschmitt-Bölkow-Blohm (MBB), which based a lot of the design on the popular BO 105, and Japanese Kawasaki. MBB eventually became a part of Eurocopter. The BK 117 can seat up to 10 people and is used in a number of utility roles such as law enforcement, sling loads and military transport, but is probably most known as an exceptional air ambulance and search and rescue platform.

Engines

The helicopter is powered by two Lycoming LTS 101-750-B1 turbo shaft engines of the free turbine type. The engine power is transmitted to the transmission via independent drive systems.

The twin-engine reliability is complemented by a fully-separated fuel system, a tandem hydraulic system, dual electric systems and a redundant lubrication system for the main transmission.

Transmission

The main transmission is a two-stage reduction gearbox. The first stage, also called the input bevel gear stage, consists of engine drive shafts, free-wheel clutches, bevel gear shafts and bevel gears to deflect the power flow. The second stage, also called collector gear stage, consists of a collector gear, bevel gear shafts and bevel gears which form the interface to the input bevel gear stage.

Fuel tanks

The total fuel quantity is stored in four flexible bladder-type tanks, two main tanks, forward and aft, and two supply tanks, all installed in the tank compartment underneath the cabin floor.

Oil tanks

Two separate oil tanks, one for each engine, are installed on the main transmission compartment floor.

LIMITATIONS

Engine limits

	Output Shaft Torque % (Ft-Lbs.)	Gas Generator Speed N-1% (RPM)	Output Shaft Speed N-2 % (RPM)	Measured Gas Temperature °C (°F)
Normal Operation				
Takeoff power (5 min.)	83 (430)	102.7 (49159)	102 (6120)	786 (1447)
Max. continuous	71 (368)	102.7 (49159)	102 (6120)	765 (1408)
One Engine Inoperative				
2.5 minimum power	100 (519)	105.6 (50548)	102 (6120)	836 (1536)
30 minimum power	91.5 (475)	104.8 (50469)	102 (6120)	800 (1471)
Max. continuous	83 (431)	102.7 (49159)	102 (6120)	765 (1408)

Rotor limits

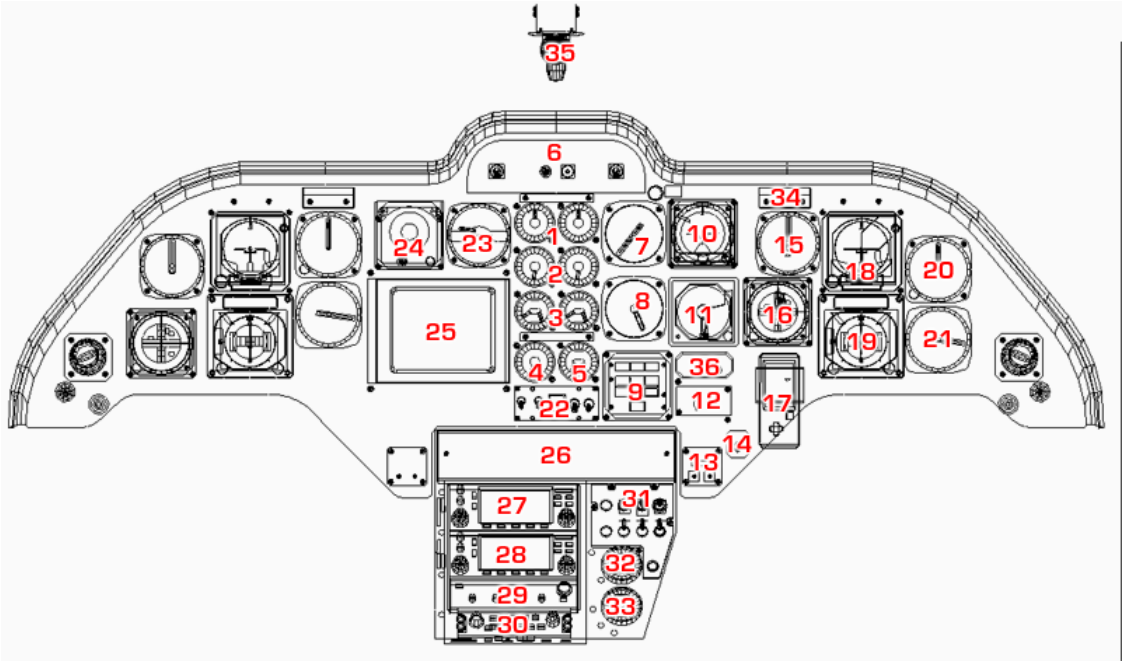
	Power On, % (RPM)	Power Off, %(RPM)
Min. Continuous		
gross weight up to 4409 lbs.	98 (376)	80 (307)
gross weight 4409 - 7385 lbs.	98 (376)	85 (326)
Max. Continuous	102 (391)	104 (399)
Max. Transient (max 12 sec.)	106 (406)	110 (422)
Min. Transient	85 (326)	–

Operating limits

Airspeed limit (IAS)	Max. VNE = 150 Kt.
Max weight	7385 lb.
Mi n crew	1 (right hand seat only)

SYSTEM DESCRIPTION

Cockpit arrangement



1. N1 percent
2. Turbine Outlet Temperature
3. Engine Oil temperature & Pressure
4. Transmission oil temperature
5. Transmission oil pressure
6. Fire control panel
7. Rotor RPM & N2 percent
8. Torque
9. Flight director mode selector
10. Standby artificial horizon
11. Radar altitude
12. HSI source selector
13. Chronometer
14. Windscreen wiper switch
15. Airspeed
16. VOR 2 indicator
17. Handheld GPS
18. Artificial horizon
19. HSI
20. Altimeter
21. Vertical speed
22. CSAS panel
23. Fuel quantity
24. Mast moment indicator
25. Weather radar
26. Annunciator panel
27. GNS 430 GPS / COMM 1 / NAV 1
28. GNS 430 GPS 2 / COMM 2 / NAV 2
29. Transponder
30. Radio panel
31. Center console switch panel
32. Ammeter
33. Voltmeter
34. Master caution
35. Compass
36. Air data display

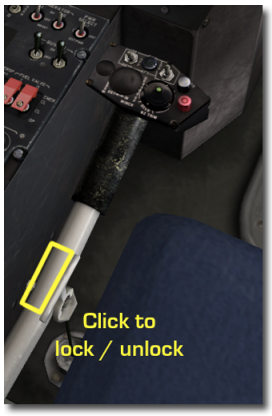
Flight Control System

Cyclic Stick

The pilot and copilot cyclic sticks are used to change the cyclic main rotor blade pitch in order to control the helicopter around the pitch and roll axis. A force trim system, including forces springs attached to electromagnetic brakes provide an artificial centering force to the cyclic sticks. Force Trim Release switches are installed to temporarily disconnect the magnetic brakes and allow re-centering of the cyclic sticks during trim changes. Trim changes can also be achieved by operating the 4-way beep trim switch on the cyclic stick.

Both the Force Trim Release and beeper trim switches are also used to control autopilot behavior.

Collective Stick



The collective stick is used to change the pitch angle of all main rotor blades in unison, thereby controlling the amount of lift generated by the rotor system.

The collective stick also features a number of switches that control various systems of the helicopter. These include:

- 3-way landing light switch (RETRACT, OFF/EXTEND, ON)
- Landing light control (fwd/aft/left/right)
- 4-way engine trim beeper switch

While on the ground, the collective lever is guarded by lock mechanism. To operate this, pull on the handle attached to the arrestor wire and hook/unhook the collective lever.

Stick Position Augmentation System (SPAS)

At high forward airspeed and mach number, compression effects shift the pressure center of the advancing main rotor blades. This causes the blades to bend, resulting in a forward flapping tendency of the main rotor. This in turn leads to a negative static longitudinal stability of the helicopter, meaning that as airspeed increases, the cyclic stick needs to be moved aft instead of forward.

The Stick Position Augmentation System (SPAS) features an electric actuator which, as a function of airspeed and collective pitch, introduces an aft cyclic control input as airspeed increases. With the system engaged, the helicopter will require increased forward cyclic input with increased airspeed during all conditions of flight.

The SPAS is controlled by a switch on the center console by which the system can be turned on, off or be tested.

3-axis Stability Augmentation System (SAS)

The 3-axis Stability Augmentation System is designed to stabilize the helicopter and minimize the effect of gusts and turbulence. The system operates by receiving angular rate signals from installed attitude rate gyros and transform these to flight control inputs. Pitch and roll axis actuators are controlled by AP1 and AP2 computers alternatively. Yaw stability actuators are controlled by the AP computer selected on the autopilot control panel.

SAS actuators are limited in authority to safeguard pilot control in case of a system failure. To avoid saturation of actuators during sustained attitude rates, such as during turns, a wash-out algorithm is implemented which gradually resets any actuator deflection over time.

All 3 axis of stabilization are switched on and off on the CSAS control panel on the main instrument panel. The yaw channel can be set in standby mode, in which no stabilization is provided but the tail rotor control linkage is protected from abrupt control inputs.

Powerplant and engine control

The BK 117 B-2 helicopter is powered by two Lycoming LTS 101-750B-1 turbo shaft engines. Power is supplied by the gas produced turbines, via the power turbines and transmission, in turn driving the main and tail rotors.

Power levers with starter switches

Power setting is controlled by managing the fuel flow to the gas producer turbine of each engine. For this purpose, two levers are installed on the overhead console of the cockpit. The left hand lever controls the left hand engine and the right hand lever controls the right hand engine.

The power control levers are marked with three settings:

- in **CUT-OFF**, fuel is cut off from the engines. This position is used during startup and during shutdown of the engines.

- the **IDLE** position is used for warm up of engines before flight or cool down during engine shut down.

- the **FLY** position is used during all normal operations, allowing full power to be drawn from the engines.

Operate the Power levers by dragging them with your mouse. Engage the engines starters by pressing your assigned keyboard shortcut command (default is ctrl+1 and ctrl+2 for Eng. 1 and 2 respectively)

Power sharing system

For optimized operation, it is necessary to match the power output of left and right engines. This is achieved by engine trim actuators controlled by a 4-way beeper switch installed on the pilots and copilots collective sticks.

When the beeper switch is moved forward and aft, the power output of both engines are increased and decreased. When the beeper switch is moved left and right, the power output is increased on the left engine and decreased on the right and vice verse, allowing the engines to be balanced.

Command and function reference for Power sharing system:

Keyb./button command	Function
bk117/engine/eng_inc	Increase both engines
bk117/engine/eng_decr	Decrease both engines
bk117/engine/eng_r	Increase right engine, decrease left engine
bk117/engine/eng_l	Increase left engine, decrease right engine

Power turbine Governor

The power control system features a governor to ensure that power turbine RPM (N2) remains within desired values for all stages of flight. The system consists of a fly-wheel arrangement, installed on the power output drive train, which is spring loaded to set the fuel flow required for nominal rotor RPM. When N2 deviates from the target value, the fly-wheel will act on the fuel control, causing a compensating increase or decrease in gas producer output. The reset spring pre-load is connected to the electric engine trim actuators by which the pilot can adjust the desired N2.

Droop compensation system

When collective pitch of the main rotor is increased, the increased drag acting on the rotor blades will cause the rotor RPM to droop. The power turbine governor will react to this by increasing fuel flow by a fraction of the N2 error, but will not restore RPM entirely. Because of this, a droop compensation system is installed by which collective pitch changes are transferred via a mechanical linkage and added to the engine trim system, causing an offset of the nominal N2 signal and therefor an increase in fuel flow. The result is that N2 and Rotor RPM is maintained when collective pitch is increased and decreased.

On the ground, with the power control levers in the FLY position, it is normal for the N2/Rotor RPM to be at 96%. When hover power is applied, this value should increase to 98-102% as set by the engine trim beeper switch.

Fuel system and Fuel Quantity Gauge

The fuel system consists of the forward and aft main tanks and left and right supply tanks. Fuel is fed from the main tanks to the supply tanks by the electric fuel transfer pumps.

During engine start, two prime pumps supply the engines with fuel. With the engines running, the engine mounted fuel pumps will draw fuel from the supply pumps and the prime pumps can be switched off. The transfer fuel pumps provides the supply tanks with fuel from the main tanks so that these are always full as long as there is fuel left in the main tanks.

A fuel quantity gauge is installed on the main instrument panel. It displays the combined remaining fuel quantity in the forward and aft main tanks and the individual quantity remaining in each supply tank.

Digital Automatic Flight Control System (DAFCS)

The BK117 DAFCS basic system consists of a Stability Augmentation System (SAS) and a Attitude Retention (ATT) system with pitch/roll auto trim and yaw damper. Two autopilot computers are used to control duplex pitch axis and simplex roll and yaw axes. Pitch axis is normally controlled by computer 1 (AP1) and roll axis by computer 2 (AP2). Yaw axis can be controlled by either AP1 or AP2.

The autopilot computers drive electromechanical actuators for pitch and roll axes and an electrohydraulic actuator for the yaw axis. Actuators are limited in authority to 4-9%. In pitch and roll axis, trim motors keep the actuators operating about their center position and prevents them from saturating. In yaw axis, the helicopter has to be kept in trim by the pilot adjusting the anti torque pedals.

The autopilot is complemented by a Flight Director (FD). When both autopilot computers are engaged and the autopilot is in ATT mode, the FD can be coupled in the pitch and roll axis to maintain flight parameters according to the mode selected on the MS-700 mode selector panel. When the autopilot is de-coupled from the FD, the pilot can fly the helicopter in ATT mode or by hand, following the FD command bars displayed in the artificial horizon.

Autopilot controller PC-700

The autopilot controller allows the pilot to engage and disengage the automatic flight control system, SAS/ATT mode selection, yaw damper source selection and coupling/de-coupling of flight director.

AP1	Push button to engage or disengage the no. 1 autopilot computer. AP1 controls pitch axis trim when AP2 is not engaged.
AP2	Push button to engage or disengage the no. 2 autopilot computer. AP2 controls the second pitch axis actuator and the roll trim actuator.
YAW 1 / 2	Selects which autopilot computer is controlling the yaw damper. When neither no. 1 nor no. 2 computers are illuminated, the yaw damper is unavailable.
SAS/ATT	Pressing this button makes the autopilot alternate between SAS and ATT modes. SAS mode is a stability augmentation mode aimed to provide 3-axis rate damping during hands on flying. The angular rate feedback makes the helicopter less sensitive to turbulent air and gusts. ATT mode provides attitude hold in pitch and roll axis when engaged. The reference attitude is captured when ATT mode is engaged and may be changed by depressing the FTR button, the beep trim on the cyclic stick or on the center console. The beep trim will change the reference attitude by 2 deg/sec in pitch and 3 deg/sec in roll. The pilot can chose to fly through the ATT system by deflecting the cyclic stick a certain amount from the trimmed position. When the cyclic is returned to center, the helicopter should return to the reference attitude automatically.
CPL	With both autopilot computers engaged, selecting a flight director mode will automatically couple the flight director commands to the autopilot, allowing the FD to set the autopilot reference attitude. The CPL button will illuminate to indicate that the autopilot is coupled. Pressing the CPL button will decouple the FD so that the FD command bars can be followed manually in either ATT or SAS mode.
FD SEL	This button alternates between the co-pilot (1) or pilot (2) HSI as the data supply to the autopilot. When the autopilot is turned on, the pilot (no. 2) HSI is selected by default.

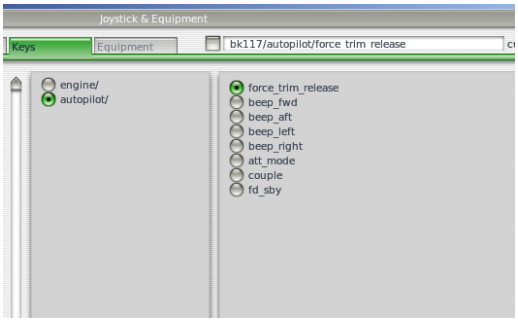
Command and function reference for Autopilot controller:

Keyb./button command	**Function**
bk117/autopilot/att_mode	Toggle between SAS and ATT mode
bk117/autopilot/couple	Flight Director couple/decouple toggle
bk117/autopilot/fd_sby	Flight Director to stand-by (decouples FD)

Force Trim Release (FTR) Switch

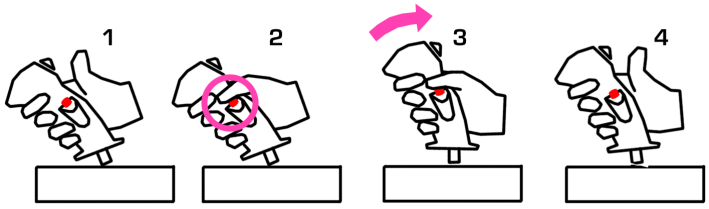
This button is found on the pilot and copilot's cyclic sticks. It is used to:

- release the electromagnetic brakes connected to the cyclic force feel springs so that the pilot can re-trim the cyclic, and
- to change the reference values for the AP or FD.



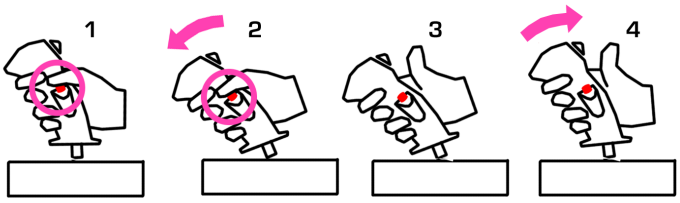
In the ND BK-117 simulator for X-plane, the FTR is realized as described below:

With autopilot in *SAS mode*, the FTR is used to easily relieve pilot of cyclic spring forces according to the following sequence of actions:



1	Joystick is deflected "out of trim", against centering springs. This typically occurs during speed/collective pitch changes.
2	FTR is depressed; X-plane temporarily disregards movement of the joystick.
3	Joystick is relaxed to it's center position.
4	FTR button is released; X-plane starts listening to joystick input again; The helicopter is now in trim and flight can continue with relaxed controls.

With autopilot in *ATT mode*, the FTR is used to change autopilot/FD references:



1	Pilot wishes to change the reference attitude held by the autopilot or the airspeed or vertical speed held by the FD (if coupled).
2	FTR button is depressed; The autopilot temporarily cuts out of attitude hold. Helicopter is maneuvered to desired pitch and roll attitude.
3	FTR button is released.
4	The joystick is quickly re-centered. The autopilot holds the new reference attitude. If autopilot is coupled to the FD in airspeed hold or vertical speed hold mode, a new airspeed or vertical speed reference is captured.

For this simulation of the BK-117, there is a command available that you can map to a joystick button for realistic simulation of the FTR switch:

Command and function reference for FTR:

Keyb./button command	AP in SAS mode	AP in ATT mode	Coupled IAS mode	Coupled VS mode
bk117/autopilot/force_trim_release	Stick cut-out; Re-trim	ATT cut-out; New ref attitude	New airspeed ref.	New vert. speed ref.

Beep trim switches

The beep switches are located on the cyclic sticks and one on the center console, next to the autopilot panel. They are used to re-trim the cyclic controls or to change autopilot/FD reference values. For this simulation of the BK-117, a number of custom commands are available that you can assign to a joystick hat switch for a realistic representation of a beep trim switch.

Command and function reference for Beep switches:

Keyb./button command	AP in SAS mode	AP in ATT mode	Coupled IAS mode	Coupled VS mode
bk117/autopilot/beep_fwd	Trim forward	Pitch - 2 deg/sec	airspeed +6 kias	vert. spd - 100 ft/min
bk117/autopilot/beep_aft	Trim aft	Pitch + 2 deg/sec	airspeed -6 kias	vert. spd + 100 ft/min
bk117/autopilot/beep_left	Trim left	Bank - 3 deg/sec	n/a	n/a
bk117/autopilot/beep_right	Trim right	Bank + 3 deg/sec	n/a	n/a

Flight Director Mode Selector MS-700

With the FD mode selector, the pilot can chose from a range of flight modes for guidance or coupling to the autopilot.

When a mode is selected, the corresponding button is illuminated as "ON". The ALT, NAV, ILS, BS mode buttons are split into ARM/CAP or ARM/GS to display whether the FD is in an armed or a captured state.

Available modes:

Mode	Function
ALT	Altitude mode: Captures and holds the current altitude when ALT button is pressed. The word "CAP" should illuminate in green. Altitude preselect: Engaged by dialing an altitude on the AL-300 air data display and pressing ALT within 15 seconds. The word "ARM" should illuminate in amber and the FD will remain in the vertical mode existing at the time of engagement. When the preselected altitude is reached, the word "CAP" will illuminate and the FD will capture and hold the selected altitude.
IAS	Holds the airspeed at the time of engagement or as set by the beep switch.

VS	Holds the vertical speed at the time of engagement or as set by the beep switch.
HDG	Turns to the heading selected by the amber heading bug on the HSI selected on the autopilot panel.
NAV	Captures and flies the radial to a VOR frequency, a GPS fix or the localizer of a tuned ILS frequency as selected on the HSI in use.
ILS	Captures and flies the glideslope of a tuned ILS frequency.
VOR APR	n/a
BC	Captures and flies the backcourse of a tuned ILS frequency
GA	n/a
SBY	Disengages all modes of the flight director

Air Data Display AL-300

The AL-300 allows pre-selection of Flight Director target altitude. It also displays target values for Flight Director IAS and VS modes.

If the SET knob is rotated while the AL-300 display is blank and the "FT" is illuminated on it's panel, the preselect altitude for the Flight Director will be set. If the ALT button on the FD mode select panel is pressed within 15 seconds, the FD will enter Altitude preselect mode and the selected altitude will be displayed until this altitude has been captured.

If either IAS or VS modes are selected on the FD mode select panel, the airspeed or vertical speed existing at the time of engagement will be displayed for 5 seconds, accompanied by "FT / MIN" or "KNOTS" being illuminated on the panel below the display. This is also the case if the target values are altered using beep trim on the pilots cyclic stick or on the center console. The SET knob can be used to alter the target value that is currently being displayed on the AL-300 unit.

MEDINAV G20T hand held GPS

This particular BK 117 is equipped with a custom made GPS unit. It is able to provide the pilot with bearing and distance to any location defined by latitude and longitude. This enables the helicopter to be navigated to locations which, for instance, does not exist in the GNS430 navigation database.

The unit consists of a back-lit LCD panel, a four-way button for setting destination latitude / longitude and a toggle button for setting the night light intensity.

The unit is not integrated with the BK 117 standard navigation systems. Directions to the target destination must be manually followed or by setting the heading bug while using the FD HDG mode.

For the typical mission, the coordinates of an emergency will be supplied by on-ground rescue personnel and relayed to the helicopter crew via the HEMS dispatch office.

NORMAL PROCEDURES

Interior Check	
Seat and pedals	Adjust
Safety belts	Fasten, adjust
Center control panel	
All switches and avionics,	OFF
except:	
GEN TRIP switch	NORM
DG switch	SLAVE
FUEL VALVE I + II	OP, guarded
Collective pitch lever	
All switches	OFF or neutral
Instrument panel	
FIRE EXT switches	NORM
AGENT DISCH switch	OFF
FIRE DET TEST switch	NORM
All switches and avionics	OFF or neutral
Clock	Set
Overhead panel	
All switches	OFF
All circuit breakers	In
Power levers	OFF
COLD START switch	NORM
HYD TEST switch	NORM
OAT	Check

Pre-start check	
PWR SELECT switch	BAT
Voltmeter indication	Minimum 24 V DC
EMER LTS switch	ARM
PWR SELECT switch	OFF - check emergency exit lights come on

PWR SELECT switch	BAT
EMER LTS switch	ARM
BUS-TIE switches	ON
FUEL PUMP PRIME switches	ON (check PRIME PUMPS caution light on)
FUEL PUMP PRIME switches	OFF
FUEL PUMP XFER switches	ON (check F PUMP XFER caution light off)
FUEL PUMP XFER switches	OFF (check F PUMP XFER caution light on)
FIRE DET TEST switch	Test - check lights come on
Instruments	Check
- Mast moment indicator	TEST
- FUEL QTY indicator	Check quantity
- MASTER warning light	Reset
ANN PNL TEST	Push, check annunciator lights come on
Flight controls	Check free movement through full travel
Collective pitch	Lock
Rotor brake lever	Pull, check ROTOR BRAKE caution light come on
Rotor brake lever	Check fully down
Cyclic stick	Lock

Before starting engines	
Fire guard (if available)	Posted
Rotor area	Clear
Anti-collision light	ON

Starting first engine	
FUEL PUMP PRIME	ON
Starter button	Depress and hold. Start clock
At 10% N1(white dot)	Power lever slowly to middle position between OFF and IDLE
TOT	Monitor, manipulate with power lever if required
N2/NRO increase	Monitor
Engine and XMSN oil pressure	Check positive indication
Power lever	Increase slowly to IDLE
At 40% N1 (white dot)	Starter button release
At IDLE RPM	Respective generator ON, check caution light extinguished
Cyclic stick	Unlock, trim neutral (minimum Mast Moment indication)

Starting second engine	

Ammeter	Operating generator, check below 100 A
Repeat items 1-9 of first engine start	
FUEL PUMP XFER (2)	ON
FUEL PUMP PRIME (2)	OFF

System Checks	
Hydraulic system check	
- Power levers	Check IDLE
- Hydraulic pressure indications	Check in green
- HYD TEST switch	HYD 1→2, check caution light come on
- Hydraulic pressure indications	Check in green
- HYD TEST switch	NORM, check caution light off
INVERTER switches (2)	ON
Artificial horizon (pilot)	Check warning flag (G) not showing
Standby horizon	ON (check warning flag not showing)
YAW sequence switch	Press, check YAW STBY segment light goes off
YAW TEST switch	TEST, check all YAW CSAS segment lights come on
YAW sequence switch	Press again, check YAW STBY segment light goes off
Note: Helicopter should not be operated with YAW CSAS switched OFF since STANDBY mode provides drive shaft protection against hard or abrupt pedal inputs.	
SPAS switch	TEST, check caution light comes on
SPAS switch	ON, check caution light goes off
Avionics checks	
- COMM/NAV equipment	ON and check
- Autopilot computers	ON
- Autopilot Yaw Source	both
- Autopilot remaining switches	As required
- All other instruments and equipment	Check and set
Bleed air heating check	
- HTR SELECT switch	BOTH
- HTR switch	ON, check ENG 1 / ENG 2 HEAT control lights come on
- HTR switch	OFF
Force Trim Release (FTR) function check	
- Power levers	Check IDLE
- Cyclic stick	Unlock

- FTR switch	Press while making small cyclic inputs in all directions; check that mast moment indication does not change
- Cyclic stick	Lock
Engine overspeed trip check	
- Power lever of engine to be checked	IDLE
- Power lever of other engine	Move slowly to FLY
- N2 of engine to be checked	Check at 90%
- OVERSPEED TEST switch	Select engine at IDLE; N2 speed must decrease
- OVERSPEED TEST switch	OFF; N2 speed must increase to previous value
Repeat procedure for second engine (first move idling engine to FLY position, then reduce other engine to IDLE).	

Pre-takeoff check	
Power levers	Move smootly to FLY position
Cyclic stick	Unlock, check neutral
N2	Trim to 96%
Engine and XMSN instruments	In green range
Fuel quantity	Re-check
All caution and warning lights	OFF
Bleed air consumers	OFF
Optional equipment	As desired
Controls	Unlock

Takeoff check	
Hover flight	Perform
N2/Rotor RPM	Adjust to 98-102%
Torque	Synchronize
Hover power	Check
Engine and XMSN instruments	Re-check
All caution and warning lights	OFF

Pre-landing check	
N2/Rotor RPM	Adjust to 98-102%
All instruments	Check
All caution and warning lights	OFF

Bleed air consumers	OFF
Autopilot	As required (SAS recommended)

Engine shutdown	
Cyclic stick	Trim neutral
Collective pitch	Lock
Power levers	IDLE, start clock
Cyclic stick	Lock
All consumers	OFF, except anti-collision light and transfer pumps
Power levers	After 2 minutes at IDLE, OFF
TOT and N1 drop	Monitor
FUEL PUMP XFER (2)	OFF
Generators	OFF
Rotor brake	Apply below 50% Rotor RPM
Anti-collision light	OFF
PWR SELECT SWITCH	OFF

CAT-A PROCEDURES

Purpose

The purpose of category A procedures is to operate the helicopter in such a manner that, if one engine fails at any time after takeoff or during landing, the helicopter can:

- Land safely and stop in the takeoff area, or

- climb out from the point of failure and attain stabilized single engine forward flight.

Takeoff Decision Point (TDP)

The Takeoff Decision Point (TDP) is determined by the height over the ground or the obstacles surrounding the takeoff area.

If a single engine failure occurs before the TDP, the emergency procedure is to set power to the One Engine Inoperative-limit, lower the nose to attain forward speed before flaring and settling down on the takeoff area.

If an engine failure occurs after the TDP, the emergency procedure is to lower the nose to 20-25 degrees nose down, accelerate to V_{TOSS} (Takeoff Safety Speed = 50 KIAS). When reaching V_Y (65 KIAS), set power to OEI limits and initiate a climb.

Landing Decision Point (LDP)

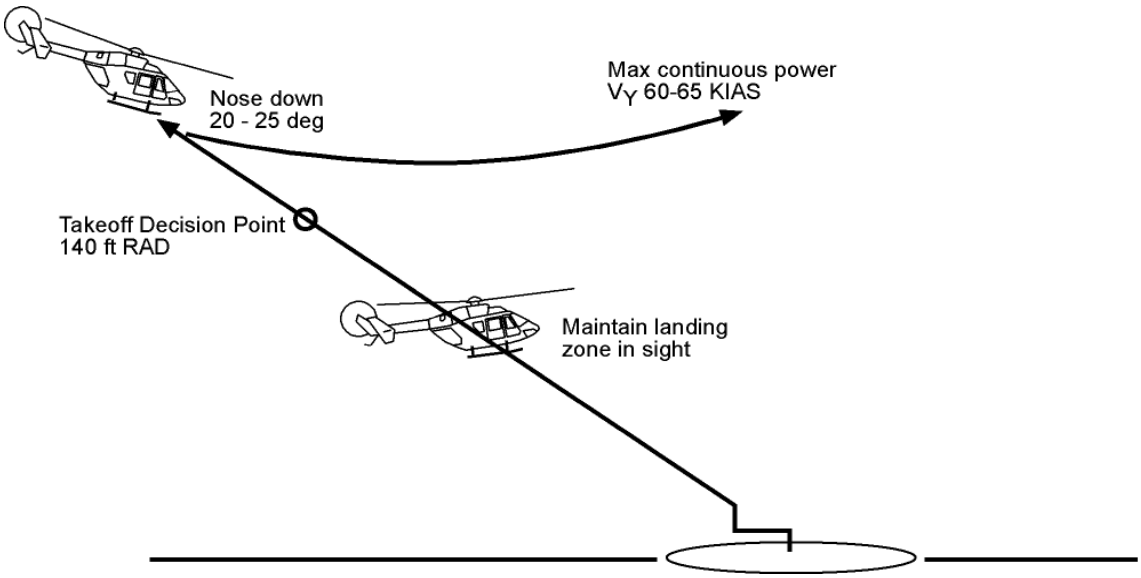
The Landing Decision Point (LDP) is a point along the approach path where height over ground or obstacles is 100 ft and the airspeed is 20 KIAS.

If a single engine failure occurs before the LDP, the emergency procedure is to set power to the One Engine Inoperative-limit, lower the nose to increase forward speed to V_{TOSS} (Takeoff Safety Speed = 50 KIAS). When reaching V_Y (65 KIAS), set power to OEI limits and initiate a climb.

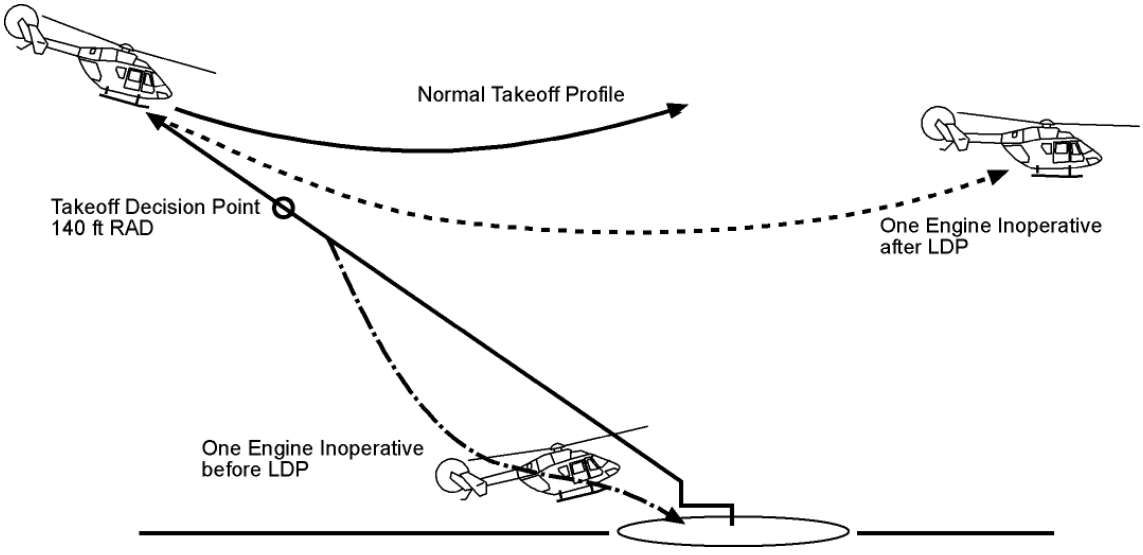
If an engine failure occurs after the LDP, the emergency procedure is to set power to the One Engine Inoperative-limit, lower the nose to attain forward speed before flaring and settling down on the takeoff area.

CAT-A Takeoff

Normal Takeoff Profile

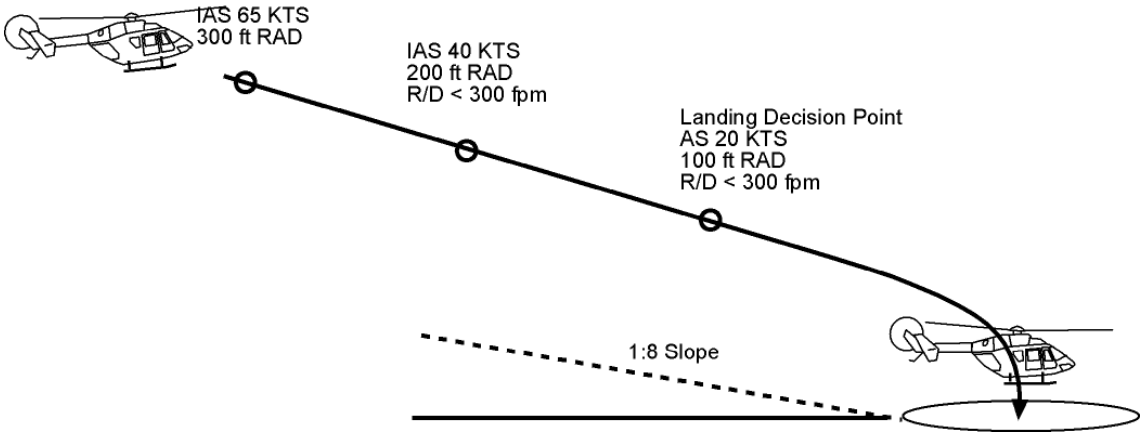


OEI Takeoff Profile

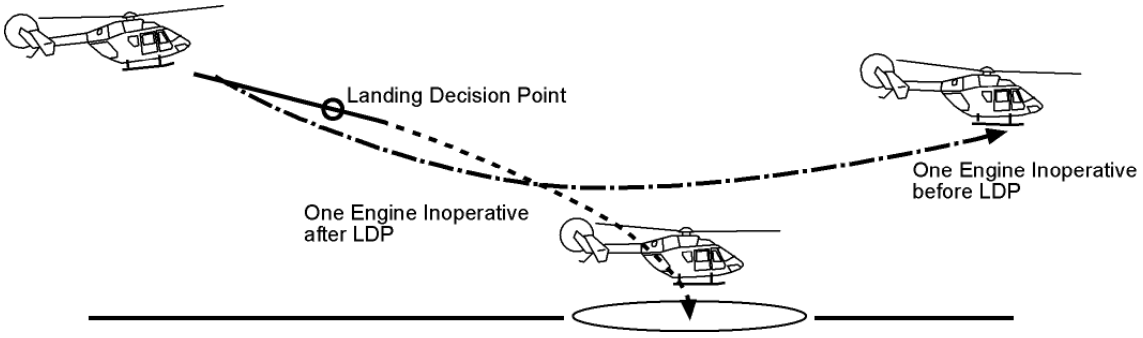


CAT-A Landing

Normal Approach Profile



OEI Approach Profile



Performance data

Climb rate

2 x Lycoming LTR 101 - 750B - 1

V_Y = 65 KIAS

Takeoff Power (786 deg C TOT, 83% TORQUE)

ISA

Gross mass, kg (lbs)	Pressure altitude (ft)	Rate of climb (ft/min)
2400 (5300)	Sea level	2800
	5 000	2350
	10 000	1750
2700 (6000)	Sea level	2400
	5 000	2100
	10 000	1400
3000 (6600)	Sea level	2175
	5 000	1725
	10 000	1150

Fuel Consumption and Endurance

2 x Lycoming LTR 101 - 750B - 1

Power as required

ISA

Level speed (KCAS)	Gross mass, kg (lbs)	Pressure altitude, ft	Fuel Consumption kg/h (lbs/hr)	Endurance (no reserve), hrs
90	2600 (5700)	Sea level	185 (408)	3,0
		5 000	170 (375)	3,3
		10 000	159 (350)	3,5
	3000 (6600)	Sea level	194 (427)	2,9
		5 000	180 (397)	3,1
		10 000	174 (383)	3,2
110	2600 (5700)	Sea level	206 (454)	2,7
		5 000	196 (432)	2,8
		10 000	198 (436)	2,8
	3000 (6600)	Sea level	214 (471)	2,6
		5 000	202 (445)	2,8
		10 000	206 (454)	2,7
130	2600 (5700)	Sea level	245 (540)	2,3
		5 000	242 (533)	2,3
		10 000	-	-
	3000 (6600)	Sea level	248 (546)	2,2
		5 000	245 (540)	2,3
		10 000	-	-

Maximum Cruising Speed

2 x Lycoming LTR 101 - 750B - 1

Maximum Continuous Power (765 deg C TOT, 71% TORQUE)

ISA

Gross mass, kg (lbs)	Pressure altitude (ft)	Max Cruising Speed (KTAS)
2400 (5300)	Sea level	138
	5 000	144
	10 000	141
2700 (6000)	Sea level	137
	5 000	142
	10 000	140
3000 (6600)	Sea level	135
	5 000	140
	10 000	136