BRONCO

OV-10

FLIGHT MANUAL

AZURPOLY

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1\ INTRODUCTION

1.1\ HISTORY

The North American OV-10 Bronco is a twin turboprop, multipurpose aircraft.

Originally designed in the 1960s by North American Aviation, it quickly gained a reputation for its versatility, ruggedness, and ability to operate across a range of tactical missions. With its counter-insurgency configuration, the Bronco was tailored to meet the needs of military forces engaged in asymmetrical conflicts, where precise observation and effective fire support are paramount.

Main identification features include high mounted, straight wing; a large glass-enclosed cockpit; twin tail booms; and swept vertical stabilizers with a high et horizontal stabilizer.

Original version is equipped with two Garrett T76 engines (military version of TPE331 engine), each developing 715 shaft horsepower.

The aircraft can fly at low altitudes with stability, as well as land and take off from short, unprepared airstrips, enabling access to remote or rugged areas inaccessible to other aircraft.

Over the decades, the OV-10 Bronco has seen extensive use by numerous armed forces worldwide, demonstrating its versatility and effectiveness across a variety of operational theaters. Its legacy endures to this day, with some modernized variants and civilian applications in fields such as firefighting and environmental monitoring.

1.2\ DEVELOPER NOTES

Original Bronco production version is the OV-10A, and was extensively used by the various USA air forces. Other variants have been created later for the export. In Europe, the OV-10B variant was produced for Germany and used as target tug. Its differences compared to the A version are:

- Transparent plastic dome instead of rear cargo door.
- Simplified rear cockpit with less instruments and no flight controls.
- No sponson/stub wings under the fuselage, as there is no need to carry weapons.

Our work is based on the OV-10 Bronco from MEAC (Musée Européen de l'Aviation de Chasse), a museum in Montélimar, France. Their aircraft is an OV-10B, still airworthy and flying in several airshows along the year. It has been transformed to look externally like an OV-10A, with a US Marines livery.

Hence, all the liveries we reproduced have the same OV-10B interior, but we created both A and B exteriors (with and without sponson, with glass or solid dome).

This project would not have been possible without the help from MEAC and its staff, that we thank very much for their help and support since several years.

Special thanks to Donald and Russ for their precious help during the beta testing. Their experience as OV-10 pilots has been key in order to develop an accurate reproduction in the simulator.

We also want to thank all the other persons who proposed their help during the project.

This manual is written based on real Bronco documentation we had access to while developing the aircraft. It has been adapted to apply to our representation in the simulator.

Do not hesitate to contact us at contact@azurpolygroup.com or on www.azurpolygroup.com.

2\ GENERAL DESCRIPTION

2.1\ SPECIFICATIONS

Those specifications apply to OV-10 A and B, as later variants had structural modifications and more powerful engines.

Weight	
Empty weight	6 900 lbs / 3 130 kg
Maximum takeoff weight	14 400 lbs / 6 530 kg
Cargo capacity (second seat removed)	3 200 lbs / 1 500 kg
Dimensions	
Wingspan	40 ft / 12.2 m
Length	44 ft / 13.4 m
Height	15.2 ft / 4.6 m
Wing area	291 sq ft / 26.40 m²
Engines	
Type	Garrett T76-G-420/421
Number	2
Peak power	715 shp
Maximum N1 speed	41 730 RPM
Reduction ratio	1:21
Propeller diameter	8.6 ft / 2.59 m
Fuel capacity (internal)	252 US gal / 950 L
Fuel capacity (medium external tank)	150 US gal / 570 L
Limits	
Service ceiling	25 000 ft
Maximum speed	250 kts
Maximum range	Around 500 nm

2.2\ DETAILED VIEWS

You will find in this section the different parts of the cockpit with their respective functionalities. Please refer to next sections to get more detailed information about each separate system. If needed, you can enable tooltips in your simulator to get a description when hovering buttons, knobs and switches.

2.2.1\ MAIN (INSTRUMENT) PANEL

1	Stores emergency release button	**24**	Lights/fire detection test switch
2	Battery 1 overheat warning	**25**	Airspeed indicator
3	Left engine overtorque warning	**26**	Artificial horizon
4	Left engine overtemp warning	**27**	Altimeter
5	Fan marker light	**28**	BDHI (bearing-distance-heading indicator)
6	Outer marker light	**29**	TACAN control panel
7	Middle marker light	**30**	Turn and slip indicator
8	Right engine overtemp warning	**31**	Vertical speed indicator
9	Right engine overtorque warning	**32**	Course deviation indicator
10	Battery 2 overheat warning	**33**	Fire warning/pull handles
11	Fire extinguisher agent switch	**34**	Engine torque indicators
12	Landing gear handle	**35**	Engine tachometers
13	VOR/TACAN switch	**36**	Turbine inlet temperature (TIT) indicators
14	Engines continuous ignition switches	**37**	Take-off checklist
15	UHF/ADF control panel	**38**	IFF light
16	Landing gear and flaps position indicator	**39**	Alarms panel
17	Elevator trim indicator	**40**	Fuel quantity indicator
18	Trim neutral lights (rudder/aileron)	**41**	Engine oil pressure indicator
19	Artificial horizon (backup)	**42**	Fuel gage select switch
20	Accelerometer	**43**	External fuel transfer switch
21	Clock/chronometer	**44**	Fuel gage test switch
22	Wheels warning light	**45**	Fuel emergency shutoff switches
23	TACAN power switch		

2.2.2\ MAIN PANEL (BOTTOM)

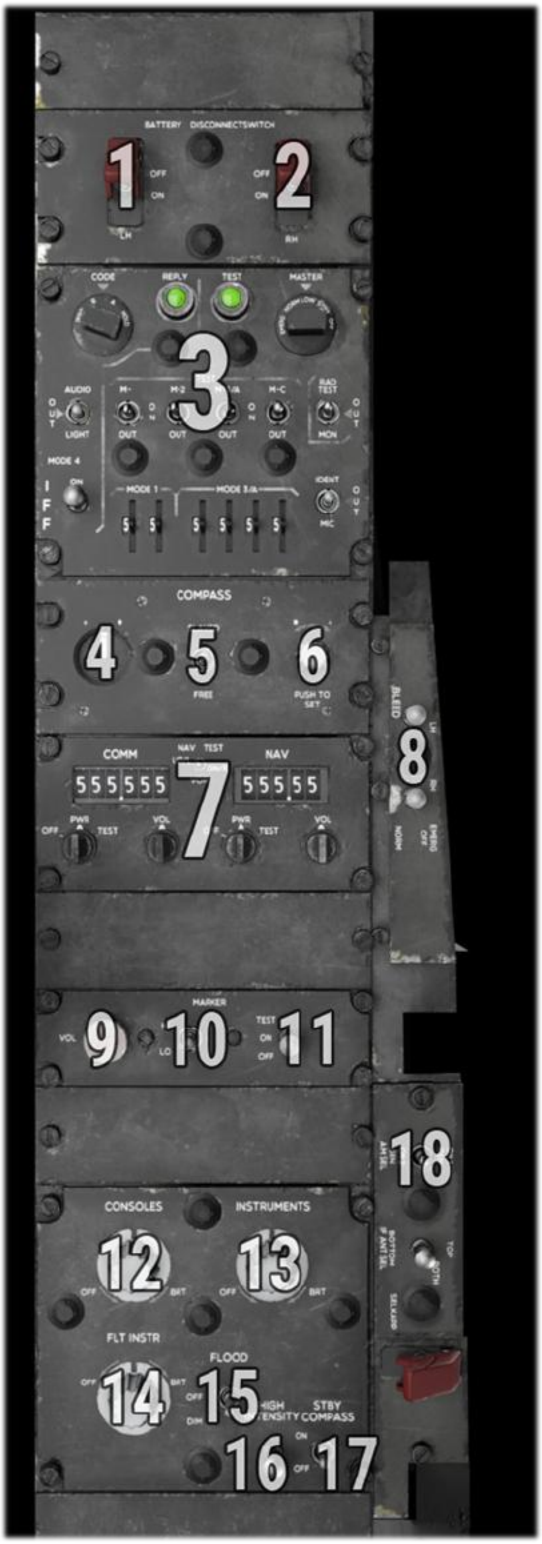
1	Emergency stores jettison handle	**9**	Cockpit air temperature handle
2	Parking brake handle	**10**	Wiper power switch
3	Rudder pedals adjust crank	**11**	Wiper speed switch
4	Hydraulic pump operation light	**12**	Ram air handle
5	Hydraulic pump low pressure light	**13**	Anti-collision light (beacon) switch
6	Voltameter/ammeter	**14**	Formation lights switch
7	Pitot heat switch	**15**	Navigation lights switch
8	Cockpit defrost handle		

2.2.3\ OVERHEAD PANEL

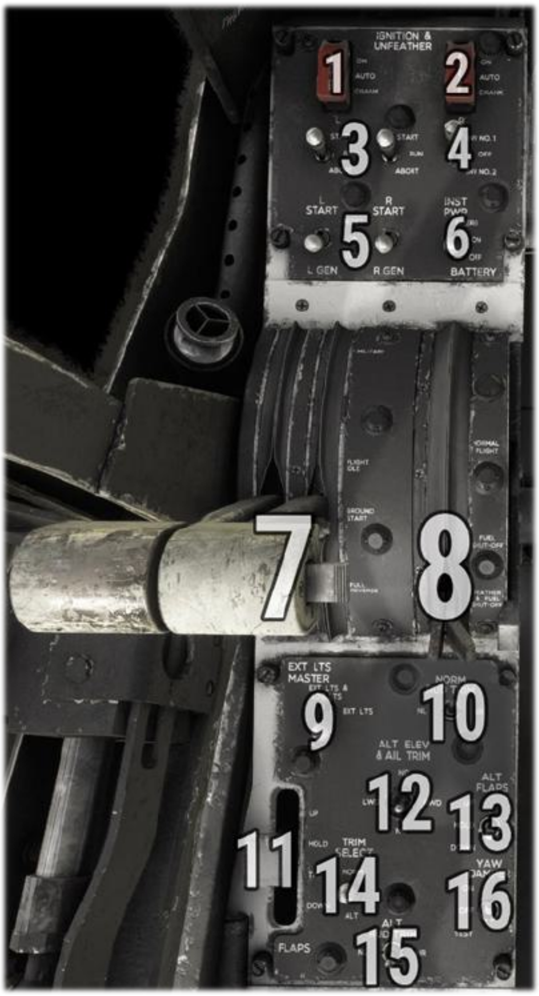
1	Standby compass	**4**	Warning horn disable switch
2	Camera power light	**5**	Gunsight filament select switch
3	Smoke generator switch	**6**	Gunsight dimming switch

2.2.4\ RIGHT CONSOLE

1	Battery 1 disconnection switch
2	Battery 2 disconnection switch
3	IFF/transponder control panel
4	Compass deviation annunciator
5	Compass mode switch
6	Gyro drift setting
7	COM/NAV control panel
8	Engine bleed air switches
9	Marker volume knob
10	Marker sensitivity switch
11	Marker power switch
12	Console lights knob
13	Instruments lights knob
14	Flight instruments lights knob
15	Flood lights switch
16	High intensity lights switch
17	Standby compass light switch
18	Ammeter alternator selection switch



2.2.5\ LEFT CONSOLE



1	Left engine air start switch
2	Right engine air start switch
3	Starter switches
4	Instruments power switch
5	Generators switches
6	Battery master switch
7	Power levers
8	Condition levers
9	Exterior lights master
10	Rudder trim switch
11	Flaps lever
12	Alternate pitch/aileron trim switch
13	Alternate flaps switch
14	Trim alternate mode switch
15	Alternate rudder trim switch
16	Yaw damper switch

3\ ENGINES

Turboprop model implemented in Flight Simulator 2020 is based on a free-turbine engine (Pratt & Whitney PT6), where there are two separate shafts:

- Gas generator shaft is connected to the compressor and the turbine responsible for extracting energy from the hot gases produced by combustion.
- Power turbine shaft is connected to the propeller and is not directly linked to the gas generator shaft. Instead, it is driven by the flow of exhaust gases from the gas generator turbine.

Turboprop engines used in the OV-10 Bronco are Garrett T-76 types, which are fixed shaft engines. In a fixed-shaft engine, the turbine and the propeller are directly connected to a common shaft. This means that the rotation of the turbine directly drives the rotation of the propeller.

Fixed shaft engines are simpler in design but behave very differently as free-turbine engines, as any change in engine speed directly affect propeller speed.

NOTE: AS THIS TYPE OF ENGINE IS NOT SIMULATED CORRECTLY IN FLIGHT SIMULATOR 2020, WE HAD TO CREATE AN ADDITIONAL LAYER OF CUSTOM CODE ABOVE DEFAULT IMPLEMENTATION TO GET A BEHAVIOUR CLOSER TO A FIXED-SHAFT ENGINE, AS EXPLAINED IN THE FOLLOWING SECTIONS.

3.1\ DESCRIPTION

Aircraft is powered by two Garrett T-76 fixed-shaft turboprop engines, rated at 715 shaft horsepower. Left engine shaft rotates clockwise and right engine shaft counterclockwise, in order to reduce torque effects. Engine consists of a two-stage centrifugal compressor, a three-stage axial turbine and a reduction gearbox.

Each engine drives a 8.5 feet, three-blade, fully reversible aluminum propeller. At maximum engine RPM (41,730), propeller rotates at 2000 RPM. Propeller pitch is adjusted by varying the oil pressure in the propeller dome, meaning it will automatically feather when engine is shut down, as oil pressure will be lost.

As it is a fixed-shaft turboprop, propeller is directly linked to the gas producer of the engine. It means that a feathered propeller needs a lot of torque to overcome the drag induced when it starts spinning. Starting with a feathered propeller is impossible as starter will have to turn both the gas producer and the feathered propeller, which will lead to engine overheating.

To prevent this, a specific mechanism called "start latches" is built into the propeller dome. Those latches can lock the propeller blades in flat pitch (close to zero degrees) where they produce very little drag. They are typically used when engine is shut down, to avoid the propellers from feathering, simplifying the next startup.

3.1.1\ CONDITION LEVERS

Condition levers control the fuel flow to the engines and have four distinct positions. They are linked to the power management control system, the engine fuel shutoff valve, and the propeller feather valves. Primary function of the condition levers is to initiate or stop fuel flow to the engines, and to select between two different power settings.

The four positions are:

- **FEATHER & FUEL SHUT-OFF**: feathers the propellers and stop engines fuel feed.
- **FUEL SHUT-OFF**: fuel is shut off but propeller feather valves are kept close, hence propellers are not necessarily feathered (depending on power levers position).
- **NORMAL FLIGHT**: normal position with minimal engine RPM (60% on ground).
- **T.O./LAND**: position for take-off and landing, where higher engine RPM is maintened (minimum 95%), in order to have quick response to any change in power lever commands.

CONTROLLER BINDINGS

Condition levers can be bound to physical controller axis/buttons to avoid using the mouse for each movement.

The following bindings are supported (see controls options in MFS settings):

BINDING NAME	EVENT	DESCRIPTION
CONDITION LEVER 1 AXIS	AXIS_CONDITION_LEVER_1_SET	Set lever position (axis) for engine #1
CONDITION LEVER 2 AXIS	AXIS_CONDITION_LEVER_2_SET	Set lever position (axis) for engine #2
CONDITION LEVER AXIS	AXIS_CONDITION_LEVER_SET	Set lever position (axis) for both engines
SET CONDITION LEVER 1	CONDITION_LEVER_1_SET	Set lever position for engine #1
SET CONDITION LEVER 2	CONDITION_LEVER_2_SET	Set lever position for engine #2
SET CONDITION LEVER	CONDITION_LEVER_SET	Set lever position for both engines
INCREASE CONDITION LEVER 1	CONDITION_LEVER_1_INC	Increase lever position for engine #1
INCREASE CONDITION LEVER 2	CONDITION_LEVER_2_INC	Increase lever position for engine #2
INCREASE CONDITION LEVER	CONDITION_LEVER_INC	Increase lever position for both engines
DECREASE CONDITION LEVER 1	CONDITION_LEVER_1_DEC	Decrease lever position for engine #1
DECREASE CONDITION LEVER 2	CONDITION_LEVER_2_DEC	Decrease lever position for engine #2
DECREASE CONDITION LEVER	CONDITION_LEVER_DEC	Decrease lever position for both engines

You can see more details for axis settings in EFB section.

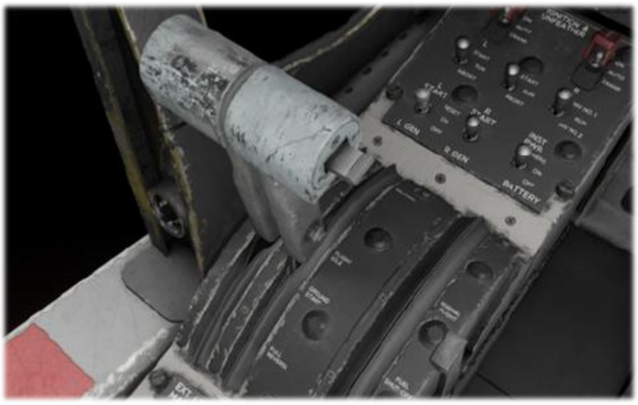
3.1.2\ POWER LEVERS

Power levers are linked to the engine fuel control units and the power management control system, and can be moved in four different zones. Primary function of the power levers is to control engine fuel flow (depending on condition lever position) and propeller thrust, and to select reverse thrust.

The four sections are:

- **FULL REVERSE**: drives the propeller blades against the reverse pitch stops to obtain maximum reverse thrust, and automatically provides required fuel flow for reverse thrust conditions.
- **GROUND START**: minimum torque at idle RPM with propeller blades set at flat pitch position.
- **FLIGHT IDLE**: provides minimum fuel flow and torque, depending on airspeed.
- **MILITARY**: provides maximum fuel flow and torque.

Selection of reverse thrust (and ground start position) is prevented in flight by a switch linked to the landing gear.



CONTROLLER BINDINGS

Power levers are using throttle axis by default. Positive throttle zone goes from FLIGHT IDLE to MILITARY positions, and reverse throttle zone goes from GROUND START to FULL REVERSE.

You can decide to manage the full range of power lever with your throttle (from FULL REVERSE to MILITARY positions), or to use buttons to toggle reverse, see EFB section. You can also change axis settings from the EFB.

The following bindings are supported (see controls options in MFS settings):

BINDING NAME	EVENT	DESCRIPTION
THROTTLE 1 AXIS	AXIS_THROTTLE1_SET	Set lever position (axis) for engine #1
THROTTLE 2 AXIS	AXIS_THROTTLE2_SET	Set lever position (axis) for engine #2
THROTTLE AXIS	AXIS_THROTTLE_SET	Set lever position (axis) for both engines
FULL THROTTLE 1	THROTTLE1_FULL	Set engine #1 power to 100%
FULL THROTTLE 2	THROTTLE2_FULL	Set engine #2 power to 100%
FULL THROTTLE	THROTTLE_FULL	Set both engines power to 100%
THROTTLE 1 CUT	THROTTLE1_CUT	Set engine #1 power to 0%
THROTTLE 2 CUT	THROTTLE2_CUT	Set engine #2 power to 0%

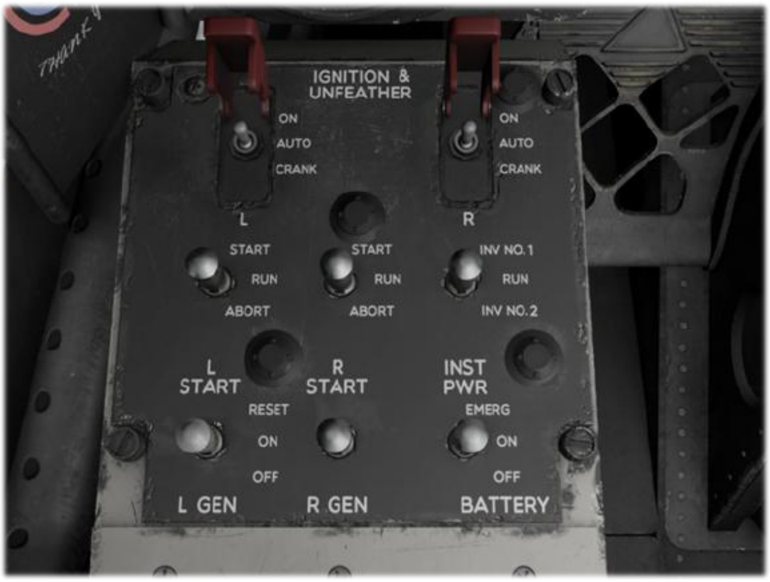
THROTTLE CUT	THROTTLE_CUT	Set both engines power to 0%
THROTTLE 1 INCREASE	THROTTLE1_INCR	Increase lever position for engine #1
THROTTLE 2 INCREASE	THROTTLE2_INCR	Increase lever position for engine #2
INCREASE THROTTLE	THROTTLE_INCR	Increase lever position for both engines
N/A	INCREASE_THROTTLE	Increase lever position for both engines
THROTTLE 1 INCREASE (SMALL)	THROTTLE1_INCR_SMALL	Increase lever position for engine #1
THROTTLE 2 INCREASE (SMALL)	THROTTLE2_INCR_SMALL	Increase lever position for engine #2
INCREASE THROTTLE (SMALL)	THROTTLE_INCR_SMALL	Increase lever position for both engines
THROTTLE 1 DECREASE	THROTTLE1_DECR	Decrease lever position for engine #1
THROTTLE 2 DECREASE	THROTTLE2_DECR	Decrease lever position for engine #2
DECREASE THROTTLE	THROTTLE_DECR	Decrease lever position for both engines
N/A	DECREASE_THROTTLE	Decrease lever position for both engines
THROTTLE 1 DECREASE (SMALL)	THROTTLE1_DECR_SMALL	Decrease lever position for engine #1
THROTTLE 2 DECREASE (SMALL)	THROTTLE2_DECR_SMALL	Decrease lever position for engine #2
DECREASE THROTTLE (SMALL)	THROTTLE_DECR_SMALL	Decrease lever position for both engines
N/A	TOGGLE_THROTTLE1_REVERSE_THRUST	Toggle reverse for engine #1
N/A	TOGGLE_THROTTLE2_REVERSE_THRUST	Toggle reverse for engine #2
TOGGLE THROTTLE REVERSE THRUST	THROTTLE_REVERSE_THRUST_TOGGLE	Toggle reverse for both engines
N/A	SET_THROTTLE1_REVERSE_THRUST_OFF	Disable engine #1 reverse
N/A	SET_THROTTLE2_REVERSE_THRUST_OFF	Disable engine #2 reverse
N/A	SET_REVERSE_THRUST_OFF	Disable reverse for both engines
N/A	SET_THROTTLE1_REVERSE_THRUST_ON	Enable engine #1 reverse
N/A	SET_THROTTLE2_REVERSE_THRUST_ON	Enable engine #2 reverse
N/A	SET_REVERSE_THRUST_ON	Enable reverse for both engines

3.1.3\ START PANEL

This panel positioned on the left console allows to manage engine start sequence, both on ground and in flight, along with unfeathering function:

- **START** switches are used on ground to engage engine start sequence. Those three-position switches are marked START, RUN, and ABORT, and return to RUN position on release. Holding the switch momentarily in START position initiates engine starter operation. ABORT position disengages the holding circuit, disables automatic ignition circuit and the starter.

- **IGNITION & UNFEATHER** switches are used to operate propeller unfeathering pumps and for air start. AUTO is their default position. CRANK will turn unfeather pump on, supplying oil pressure to the propeller governor and setting propeller angle within the beta range. When used in flight, propeller will start windmilling due to the drag they produce. ON position also triggers unfeather pump, but fuel is introduced for an air-start along with ignition.



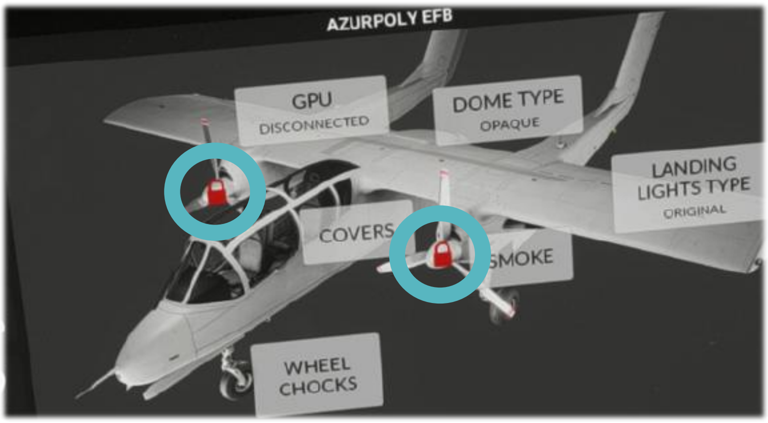
NOTE: OV-10B VARIANTS ALSO HAVE "CONTINUOUS IGNITION" SWITCHES ON THE FRONT PANEL, WHICH ARE USED TO REDUCE ENGINE FLAMEOUTS RISKS WHEN FLYING IN ICING CONDITIONS.

3.2\ OPERATION

3.2.1\ ON GROUND

As explained in previous sections, propellers must be "on the latches" (start latches engaged) and not feathered before starting the engine. In order to start, put the starter switch on START position and move condition lever to NORMAL FLIGHT position once 10% RPM is reached. Engine will stabilize at approximately 60% RPM.

In order to "unlock" start latches, power lever needs to be briefly put in reverse range. At this moment, propeller can operate in their full beta range. You can check on the EFB that padlock logo disappeared.



While taxiing, condition lever should be kept in NORMAL FLIGHT position and power levers can be used in their full range to get desired thrust. Reverse range is commonly used when taxiing the Bronco in order to turn more easily by using differential thrust.

Before takeoff, condition lever is put in T.O./LAND position which will set the engine at 95% RPM minimum, ensuring a quick response to power lever changes.

3.2.2\ IN FLIGHT & FAILURE

After takeoff, condition lever can be set in NORMAL FLIGHT position for the whole flight. Before landing, condition lever is set again in T.O./LAND position to ensure a quick response to any power change.

In case of engine failure or shutdown while in flight, the propeller will be automatically feathered as a result of the huge aerodynamic load. The propeller control systems also incorporate dump (feather) valves which allow the pilot to manually select feathering as required (using condition levers).

In order to restart engine in flight, IGNITION & UNFEATHER switch needs to be placed on position ON, which will run unfeather pump and initiate an engine start thanks to windmilling.

3.2.3\ MONITORING

Engine is monitored with several gauges positioned on main instrument panel:

- Torque on each engine shaft.
- Engine RPM (percent).
- EGT (Exhaust Gas Temperature) / TIT (Turbine Inlet Temperature).
- Oil pressure.

EGT/TIT gauge is important as the engine can be subject to overheating. During engine startup, EGT is indicated, which is the temperature of the exhaust gases. Once 50% RPM is reached, TIT is indicated. TIT corresponds to the temperature of combustion chamber gases as they enter the turbine unit. It is a "virtual" parameter as no probe could support the temperature at this location. It is calculated from EGT value, taking several other parameters into account. TIT is easier to monitor as its maximum allowable value is always approximately 1000 °C, whatever the altitude, airspeed and engine RPM.

TIT warning lights will light up at 996 °C.

Oil temperature is automatically regulated, with a radiator located above each engine. Oil cooler flaps are directly linked to landing gear operation and are opened when landing gear is extended, allowing to increase oil cooling at low speeds.

3.2.4\ FIRE

Two handles located on main panel will light in red in case of engine fire.

Pulling one of the handles will close emergency fuel valve of the engine in order to stop fuel feeding.

Each engine has a dedicated fire extinguisher system installed in its nacelle. This system is armed by the respective FIRE PULL handle, and completely discharged when FIRE EXT switch is placed to AGENT position.

4 \ FUEL SYSTEM

Fuel system consists of five internal tanks and one optional external tank.

4.1\ DESCRIPTION

Internal fuel is carried in five self-sealing, unpressurized wing cells. There are two inboard, two outboard, and one center tank. Approximately 250 gallons of usable fuel are split between those tanks.

Fuel from outboard tanks flows to the inner tanks and then to the center tank, all by gravity. Center tank includes a sump portion, which acts as an engine feed tank.

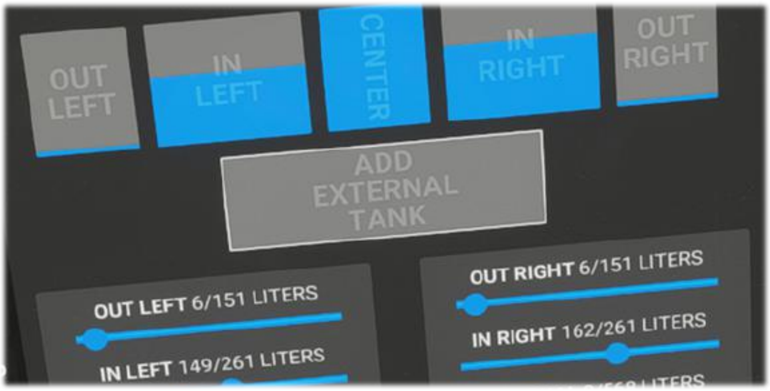
Engine-driven boost pumps allow to feed the engine.

	Tank capacity	
	GALLONS	POUNDS
Wing outboard (2 tanks)	80	520
Wing inboard (2 tanks)	138	897
Center/feed	40	260
TOTAL	**258**	**1677**

4.2\ EXTERNAL TANK

External fuel can be optionally carried in a single 150 gallons tank installed at the centerline fuselage station.

This tank can be added or removed from the EFB:



NOTE: ANOTHER 230 GALLONS EXTERNAL TANK EXISTS BUT IS NOT IMPLEMENTED ON OUR AIRCRAFT YET.

Fuel is transferred from the external tank to the wing center/feed tank by an electrically driven transfer pump in the external fuel transfer line. It is manually switched on using EXT FUEL TRANS switch. Normal rate of transfer from the external tank is 750 pounds per hour (115 GPH). Fuel is transferred to the center tank, and may flow to inboard/outboard tanks if center tank is full already.

Pump should be turned off once all external tank fuel has been transferred, to prevent the transfer pump from running dry.

4.3\ FUEL GAUGE

Fuel gauge is positioned on the bottom right of instrument panel and indicates fuel level (in LBS x 100) depending on fuel gage select switch position:

- Internal fuel (five tanks).
- Feed tank (center tank).
- External fuel.

In order to test the gauge, an unstable switch can be held to the right and should result in the indicator monitoring toward zero.

5 \ ELECTRICAL

5.1\ DESCRIPTION

Main type of electrical power supply is 24 VDC, supplied by two batteries, two generators and ground power (if needed).

Some equipment requires AC (alternative current) which is made available by converting 24 VDC into 115 VAC using two inverters (one primary and one backup).

Electrical installation is divided into several busses to manage power distribution:

- **Battery bus (DC):** provides power to emergency equipment and is powered by the batteries at all time.
- **Primary DC bus:** main distributor of aircraft electrical power, providing power to all normal mission DC powered equipment.
- **Secondary DC bus:** provides power for non-essential equipment (lighting, communications equipment).
- **Primary AC bus:** provides power to instruments that need AC power.

Instruments are powered with the following switch (which toggles inverters):

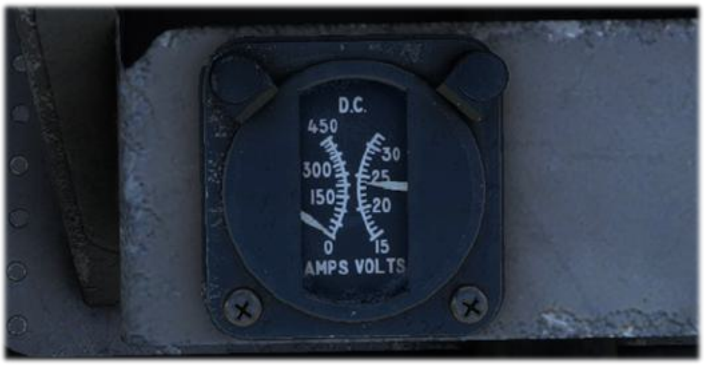
5.2\ BATTERIES

Two 24 volts, 22 ampere hour nickel-cadmium batteries are installed for engine starting and emergency electrical power.

When fully charged, they are capable of providing sufficient power for approximately three unsuccessful engine ground start attempts.

In addition to master battery switch on left console, each of the two batteries can be connected or disconnected from right console switches.

A gauge shows voltage of the primary bus, allowing to monitor the batteries state.



5.3\ GENERATORS

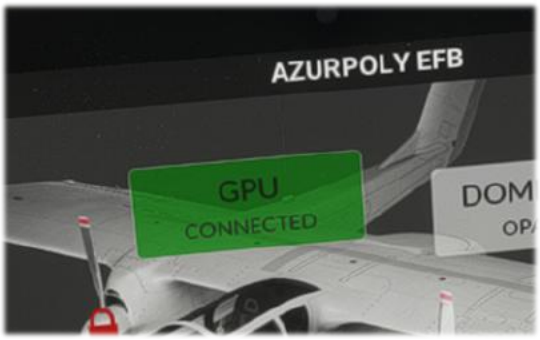
Each engine ships an independent generator, fully functioning once engines reach 50% RPM. They are supplying 30 volts DC at 300 amperes to the DC buses.

Single generator operation is capable of supplying sufficient power required for all electrical loads. They also act as engine starter motors during startup.

5.4\ GROUND POWER

External DC power can be used for engine starts when battery power is not sufficient.

It is plugged after clicking on the EFB button:



5.5\ LIGHTS

5.5.1\ EXTERIOR

Following exterior lights exist on the Bronco:

- Anticollision (beacon) light.
- Position (navigation) lights.
- Formation lights.
- Taxi/landing lights.

Master exterior lights switch, located on left console, allows to switch between three states:

- **OFF:** all exterior lights are off irrespectively of other light switches.
- **EXT LTS:** each exterior lights can be turned on with its dedicated switch.
- **EXT LTS & LDG LTS:** same as previous position but taxi/landing lights are turned on.

Below front panel, anticollision light, position lights, and formation lights can be managed independently. Two different intensities can be selected (except for anticollision):

- **DIM:** medium intensity.
- **BRT:** higher intensity.

Original Bronco has a low intensity light in the nose for taxi/landing. Modern lights have been retrofitted on some modern models in the wings to have a better visibility during night flying. You can apply this modification from the EFB.

5.5.2\ INTERIOR

Interior lights are managed from right console:

- Consoles lights (red light for side consoles).
- Instrument lights (white light for secondary gauges).
- Flight instrument lights (white light for most important gauges).
- Flood lights (main panel).
- High intensity lights (additional light for consoles).
- Standby compass light.
- Cargo bay light.

5.6\ ALARMS

Several alarms exist in the cockpit and are described in next subsections.

A three positions unstable switch allows to test alarms:

- When held to the left, all alarms illuminate.
- When held to the right, fire detection system is tested.

5.6.1\ ALARMS PANEL

This panel gathers main warning and caution lights (two colors depending on severity).

LIGHT	COLOR	MEANING
Fuel feed warning	Red	Less than 50 pounds of fuel in feed tank
Generator caution One per engine	Amber	Generator off line
Fuel low caution	Amber	Less than 225 pounds of fuel in center wing tank
Chip warning One per engine	Red	Iron-metallic particles on chip detector
Spoiler authority	Amber	System malfunctioning if light stays on
Instruments power	Amber	Primary A-C bus (instruments) power failure
Fuel boost One per engine	Amber	Fuel boost pump motive flow output low
Start ignition on	Amber	Either engine starter or ignition operating

5.6.2\ OTHER ALARMS

WHEELS warning light is located on main panel to signal that landing gear is not down. This red light flashes when any gear is not securely extended and locked with at least one condition lever in T.O./LAND position and:

- Both power levers retarded.
- Or flaps are extended to 30 degrees or more.

A sound can also be heard with the same frequency.

Other warning lights are located below main panel hood. Those lights can be pushed to be tested and rotated in order to set their brightness.

LIGHT	COLOR	MEANING
Overtorque caution (TOR) One per engine	Amber	Engine torque above 2,200 pound-feet
Overtemp caution (TIT) One per engine	Red	Engine turbine inlet temperature (TIT) above 996 °C
Battery warning One per battery	Red	Battery overheating
Hydraulic pressure	Amber	Hydraulic pressure below 200 PSI

5.6.3\ STALL

A rudder pedals shaking mechanism is incorporated in the aircraft. In the event of a stall, rudder pedals will start shaking to indicate to the pilot that aircraft is stalling.

6\ HYDRAULICS

The Bronco has hydraulic power used for:

- Landing gear operation.
- Flaps.
- Nose wheel steering.
- Wheel brakes.

Flight controls are fully mechanical and do not need any hydraulic power.

6.1\ HYDRAULIC GENERATION

Hydraulic generation consists of a single circuit with an electrically operated hydraulic pump. Hydraulic power at 1500 to 1550 psi is supplied by this system. Hydraulic power package, including the reservoir and hydraulic pump, is installed as a swing-down assembly above the cargo bay, aft of the wing. This hydraulic power is necessary for the normal extension and retraction of the landing gear, the normal extension and retraction of wing flaps, as well as for the nose wheel steering system.

During nonduty periods, hydraulic pump is turned off, leaving residual pressure in the lines last pressurized.

Brake hydraulic lines are fed by a separate manually operated hydraulic system and actuated by both rudder pedals.

Two lights allow to monitor hydraulic generation:

- Green light on when hydraulic pump is operating.
- Amber light on when hydraulic pressure is falling below 200 psi.

6.2\ LANDING GEAR

6.2.1\ LANDING GEAR

The Bronco has a tricycle-type landing gear, with main gear retracting backwards and nose gear retracting forward. It is hydraulically actuated. In case of power failure or a malfunction in the normal extension circuit, the gear can be extended manually but not retracted.

When on ground, a safety switch will prevent any retractation of the landing gear. Normal retraction requires approximately 10 seconds, and extension requires approximately 7 seconds.

LANDING GEAR WARN HORN

As described in alarms section, a landing gear warning horn will sound simultaneously with the WHEELS warning light illumination. This horn can be turned off by momentarily positioning the WARN HORN DISABLE switch to OFF.

LANDING GEAR UNSAFE LIGHT

The pilot's landing gear handle incorporates a gear unsafe light. This red light is illuminated whenever the landing gear is not locked in the position demanded by the gear handle.

LANDING GEAR POSITION INDICATOR

Landing gear position indicator is located on main panel, integrated with flaps position indicator. Landing gear position is reflected by an indicator for each gear. Landing gear up, down, and intermediate positions are indicated.

6.2.2\ STEERING

Nose wheel steering can move 55 degrees left or right, facilitated by a hydraulically operated nose wheel steer-damper system. When the aircraft is resting on the landing gear, hydraulic system pressure is directed through a steering control valve to the steer-damper unit.

The STEER button for the nose wheel is located on the front side of the pilot's stick grip. In the real Bronco, continuous depression of this button is needed in order to operate nose wheel steering.

In the simulator, the system is simplified and nose wheel steering is enabled by default. You can disable steering by pushing the STEER button, and you will need to taxi using differential engine thrust, as it is commonly done on the real aircraft.

6.2.3\ TIRES

Tires are key components as the Bronco is commonly used to land on rough terrains. Tire pressure and effect of aircraft weight has been simulated. You can change tire pressure from the EFB.

6.3\ FLAPS

A wing flap system with four sections, featuring slots, is integrated into the aircraft. Each wing has one inboard and one outboard section positioned on either side of the tail boom. Hydraulic system power ensures standard operation.

Flaps can be set to any position between 0 and 40 degrees.

Slot doors on the lower wing surface, extending mechanically with the flaps, manage boundary layer airflow.

Additionally, an electrically powered alternate flap system is available for extending and retracting control in case of hydraulic system failure or normal flap control circuit failure.

6.3.1\ FLAPS POSITION INDICATOR

Flaps position indicator is integrated with landing gear position indicator on main panel, indicating up, ¼, ½, ¾, and down positions.

6.3.2\ FLAPS HANDLE

Flaps handle is located on the left console, in order to operate flaps through their 40° range**,** with four separate positions:

- UP to set flaps up.
- HOLD to stop flaps at their current position.
- T/O to set flaps to takeoff position (20 degrees).
- DOWN to set flaps fully down.

Flaps are fully retracted in approximately 8 seconds**.**

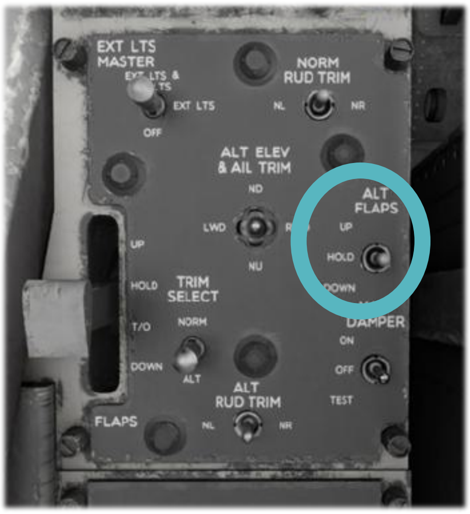
NOTE: YOU CANNOT BIND A CONTROLLER AXIS TO THE EXACT SAME POSITIONS AS THIS LEVER BECAUSE OF TECHNICAL LIMITATIONS (HOLD POSITION DOES NOT EXIST IN THE SIMULATOR). HOWEVER, YOU CAN BIND UP, TAKEOFF AND DOWN POSITIONS AND LEVER WILL MOVE ACCORDINGLY.

6.3.3\ ALTERNATE FLAPS SWITCH

ALT FLAPS switch is located on the control panel (left console).

In case of failure in the normal hydraulic power or electrical control, alternate flaps switch can be used to reach the desired flaps position, with power supplied by primary DC bus.

When using ALT FLAPS switch, make sure that FLAP handle is in HOLD position to prevent unintentional activation of the normal flaps system. The switch has UP, HOLD, and DOWN positions and is spring-loaded to the HOLD position.



6.4\ BRAKES

Hydraulically independent wheel brakes, manually operated, are installed. Each wheel has its own brake master cylinder, activated by pressure on the rudder pedals.

PARK BRAKE handle is located on the pilot's center pedestal. To engage parking brake, pedal pressure is applied as needed, followed by pulling out the handle and releasing pedal pressure.

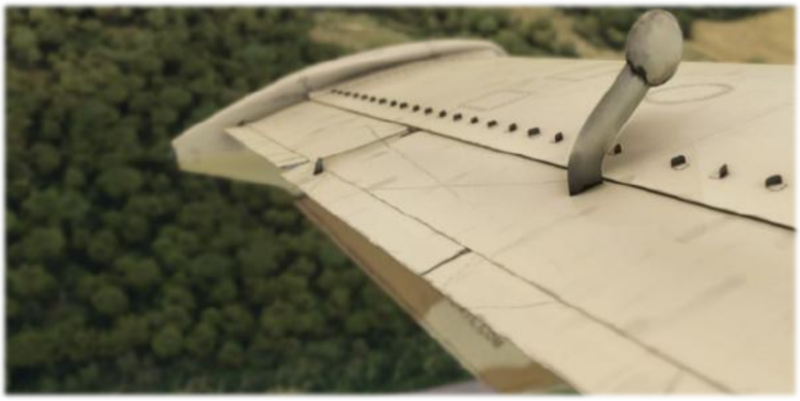
7\ FLIGHT CONTROLS

Elevator, ailerons, and rudder are reversible, balanced mechanical systems operated by cables, rods, and bell cranks. The primary in-flight movement of the ailerons and elevator is accomplished through the aerodynamic action of spring and gear-operated boost tabs. Electrically operated trim bungees are responsible for control force trim, moving the flight control systems to no-load positions as needed.

7.1\ LONGITUDINAL SYSTEM

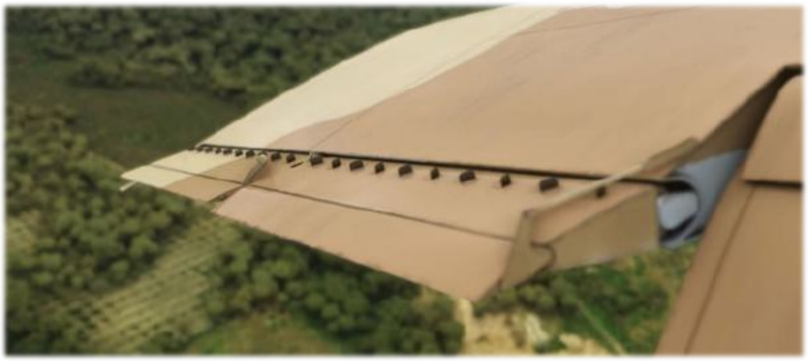
Longitudinal system (pitch) consists of a horizontal stabilizer and a tab-boosted elevator. The tab system consists of four trailing edge segments extending the entire span of the elevator.

In flight, the spring (outboard) tabs are driven by the control stick in the direction opposing desired elevator movement, displacing the elevator by aerodynamic reaction until spring tab stops are contacted.



7.2\ LATERAL SYSTEM

Lateral system consists of ailerons boosted by spring and gear tabs, augmented by spoilers. Operation of the outboard tabs is as follows: during in-flight control stick initial movement, the tabs are displaced, driving the ailerons by aerodynamic reaction until the spring tab stops are engaged. Subsequent lateral movement of the control stick directly actuates the ailerons.



Four fan-shaped, axially hinged spoiler plates, rotating upward, are installed in each wing.

Displacement of the ailerons triggers mechanical linkage to rotate the spoiler plates upward from the down-going wing, generating extra rolling reaction as a result of lift loss. When the control stick reaches its maximum lateral travel, the spoilers are displaced by approximately 86 degrees.

7.3\ DIRECTIONAL SYSTEM

Directional system consists of dual vertical stabilizers, twin rudders, and an electromechanical yaw damper system. Rudders are not tab booster and are displayed by direct mechanical action through the rudder pedals.

Yaw damper system supplies a control torque to the rudders proportional to aircraft yaw rate and oscillation frequency and in the opposite direction of the yaw motion. Pilot control of the system is obtained through a three-position toggle switch:

- **ON:** normal position in flight.
- **OFF:** yaw damper clutch is disengaged.
- **TEST:** permitting damper system operational testing on ground.

When the aircraft is on ground (struts compressed), yaw damper is automatically disengaged.

7.4\ TRIM

Trim is available on the three axis and is fully electrical. Two separate circuits (normal and alternate) allow to handle any failure.

7.4.1\ ELEVATOR AND AILERON TRIM

Regular aileron and elevator (roll and pitch) trim switch is located on the stick grip. This knob is not animated in the simulator as it is hardly usable.

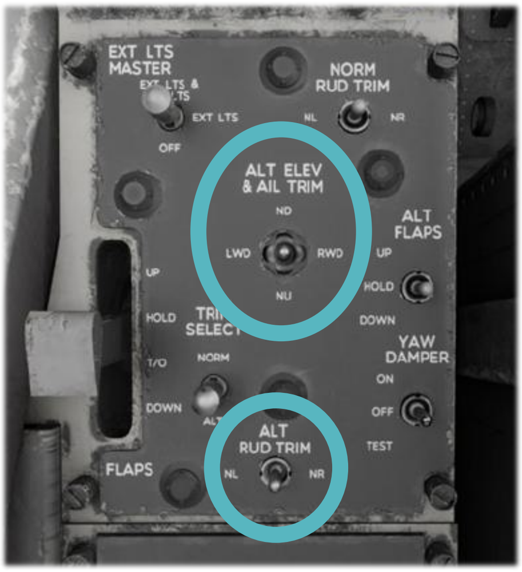
7.4.2\ RUDDER TRIM

Rudder trim is actuated via NORM RUD TRIM switch located on left control panel.

7.4.3\ ALTERNATE TRIM

TRIM SELECT switch is positioned next to the flap handle. In the NORM position, primary DC bus power is allocated for aileron and elevator trim, regulated by the stick grip trim switch, and for rudder trim through the NORM RUD TRIM switch (panel-mounted), as described previously.

Switching to ALT position engages an alternate primary DC bus power source, and trim adjustments are made using the alternate elevator and aileron trim, as well as the alternate rudder trim switches.



7.4.4\ TRIM INDICATION

Main panel hosts the elevator trim indicator. This indicator shows trim position from full nose-up (NU) to full nose-down (ND).

Aileron and rudder trim neutral lights are installed on main instrument panel. Those green, press-to-test lights, powered by the primary DC bus, indicate neutral position for roll and yaw trim.

8\ AVIONICS

Our Bronco has been modeled with its original avionics only, except an optional GPS unit that you can use if needed. While the Bronco is not well suited for IFR flights, it has radio navigation capabilities (VOR, ADF, TACAN) and can perform ILS approaches.

8.1\ COM/NAV

On right console, a COM/NAV panel allows to set COM1 and NAV1 frequencies.

1	COM power knob	**7**	NAV frequency knob (units)
2	COM frequency knob (units)	**8**	NAV frequency knob (decimals)
3	COM frequency knob (decimals)	**9**	NAV volume knob
4	COM volume knob	**10**	NAV frequency
5	COM frequency	**11**	NAV test switch
6	NAV power knob		

Marker panel is located on same console in order to manage ILS marker.

1	Volume knob	**3**	Power/test switch
2	Marker sensitivity knob		

8.2\ ADF

UHF/ADF panel is used to set ADF frequency.

- On left side, a knob allows to switch between preset channels and manual frequency selection. You need to put this knob on MAN position in order to use your frequency (preset channels are not simulated).
- On right side, the power knob needs to be set on ADF position.

1	Power knob	**6**	Frequency knob (decimals)
2	Volume knob	**7**	Mode knob
3	ADF frequency	**8**	Preset channel knob
4	Frequency knob (tens)	**9**	Preset channel selection
5	Frequency knob (units)	**10**	Squelch disable switch

In order to follow a NDB radial, please check BDHI section.

8.3\ TACAN

TACAN panel is located on center pedestal. Channel can be selected with two wheels on the left side.

A click spot has been added on top left in order to switch TACAN mode (X/Y), as older TACAN installations did not have mode selection.

Function knob is used to switch between different modes:

- **OFF:** System off.
- **REC (Receive):** System indicates magnetic bearing to selected station.
- **T/R (Transmit/Receive):** System indicates magnetic bearing and distance to selected station.
- **A/A (Air/Air):** System indicated distance to other TACAN-equipped aircraft (not simulated).

1	Function knob	**4**	Channel setting wheel (third digit)
2	Volume knob	**5**	Mode setting button
3	Channel setting wheel (first two digits)		

In order to follow a TACAN radial, please check CDI section.

8.4\ BDHI

Bearing-distance-heading indicator (BDHI) shows aircraft heading depending on compass panel settings.

It has the following control panel:

1	Deviation annunciator	**3**	Gyro drift setting knob
2	Compass mode switch		

In SLAVED mode, compass operation is automatic with magnetic heading slaved to earth's magnetic field as sensed by a remote compass transmitter.

In FREE mode, compass operation is tied to directional gyro and BDHI heading indication must be periodically corrected for gyro drift using PUSH TO SET knob (left or right rotation).

On the left, an annunciator shows disagreement between compass gyro and magnetic compass transmitter, in SLAVED mode only.

On the BDHI, small (simple) needle indicates direction to ADF station based on current frequency set on ADF panel.

Double needle indicates VOR or TACAN direction depending on current position of VOR/TACAN switch.

On range indicator window, distance to TACAN station or to DME station (if NAV is equipped with DME) is indicated in nautical miles.

1	Top heading index	**4**	Range indicator
2	ADF pointer	**5**	Warning flag
3	VOR/TACAN pointer		

VOR/TACAN twitch is located on top left of instrument panel.

8.5\ CDI

A course deviation indicator (CDI) is installed on instrument panel. Course is selected using the knob and indicated in top window.

Heading pointer indicates difference between current aircraft magnetic heading and selected course.

1	Heading pointer	**6**	Course selection knob
2	Course deviation bar	**7**	Selected course
3	NAV flag	**8**	TO/FROM indicator
4	Glideslope deviation bar	**9**	ILS marker light
5	Glideslope flag		

Depending on current position of VOR/TACAN switch:

- Course deviation bar shows current deviation from selected course based on VOR/ILS or TACAN station.
- Glideslope bar shows current slope deviation in case of ILS approach.

Push-to-test light on top right corner will illuminate during ILS approaches when a marker is intercepted.

8.6\ IFF/TRANSPONDER

Identification friend or foe (IFF) panel is located on right console.

As IFF does not have any usage within the simulator, this panel is simplified and only used to manage aircraft transponder:

- Power knob to switch between OFF, STDBY and NORM (ALT) states.
- Four code dials (mode 3 section) to set transponder code.

1	Power/mode knob	**2**	Transponder code selection

8.7\ OPTICAL SIGHT

As the aircraft is capable of carrying varied munition loads, an optical sight is optionally fitted in the pilot's field of view and can be displayed from the EFB.

The sight is turned ON by turning the reticle brightness knob clockwise on gunsight control panel. The reticle consists of a 2 mil pipper with quarter markings.

Sight depression lever allows variable depression settings from 0 to 270 miles.

An adjustable polaroid filter can be lifted behind the reflecting glass during daylight operation in order to increase contrast between objects and the reticle.

8.8\ GPS

We fitted an optional GPS unit which you can display from the EFB. This unit is connected to COM1 and NAV1 frequencies. First option is to display Working Title GNS 430 which is available by default in the simulator. If you own PMS50 GTN or TDS Sim GTNXi add-ons, you can use their GTN 650 unit (PC only).

9\ EXTERNAL STORES

The Bronco is capable of carrying varied conventional munition loads, including general purpose bombs, rocket packages, fire bombs, etc. Machine guns are functional in our model but all other weapons cannot be fired for now (planned in future updates).

Because of Microsoft policy, weapons cannot be used if you bought our product on the Marketplace. In order to use them, you need to install the patch available on our website (PC users only).

Please note that only OV-10A variant can embark weapons as OV-10B does not have sponsons below its fuselage.

9.1\ WEAPONS

Weapons can be optionally displayed from a specific EFB menu.

The following equipment can be selected:

- Four M60C (7.62mm) guns.
- Two AIM-9 Sidewinder air-air missiles.
- Two LAU-61 rocket launchers (19 rockets each).
- Two LAU-68 rocket launchers (7 rockets each).

Machine guns will fire using a dedicated button on the throttle, or by binding a controller button to WAR EMERGENCY POWER event in controls options.

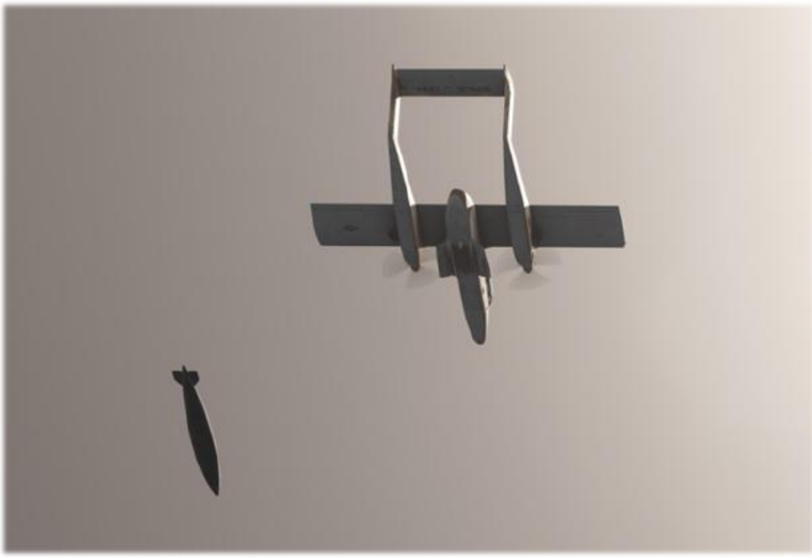
9.2\ JETTISON

In case of emergency, external loads can be jettisoned.

On center pedestal, emergency jettison handle allows to release all stores except the centerline (external tank).

On main panel, emergency stores release button allows to release all stores including the external tank.

External fuel tank ejection is animated.



10\ ELECTRONIC FLIGHT BAG

To help managing all actions related to the aircraft, an EFB has been implemented, similarly to all our other aircrafts.

Screen luminosity can be set from the top bar.

EFB can be closed with a click on its main button, and reopened from a button on front panel. It can be moved on the seat by clicking on its right border.

10.1\ AIRCRAFT

First page covers main functions related to the aircraft:

- GPU connecting and disconnecting.
- Wheel chocks display.
- Aircraft covers display.
- Switch between original and modern landing lights.
- Switch between solid and glass cargo dome.

To bypass manual actions, pre-defined configuration can be set:

- Cold & dark (all off).
- Aircraft started.
- Takeoff configuration.

10.2\ DOORS

On the left column, several checkboxes for:

- Yoke display.
- Copilot display.
- Gunsight display.
- Toy display.

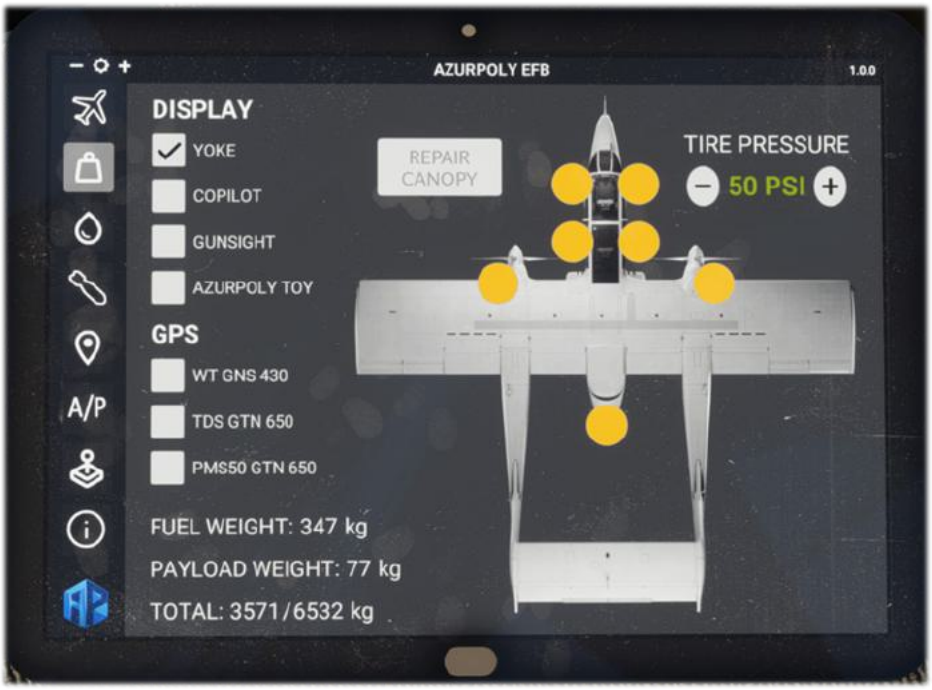
GPS unit can be selected (GNS 430 or GTN 650) or completely hidden.

Just below, a weight recap is displayed with fuel weight, payload weight and total weight, in order to check that maximum takeoff weight is not exceeded.

Inside aircraft top view, each canopy can be opened and closed, along with engine maintenance doors and rear cargo door.

Other functions are:

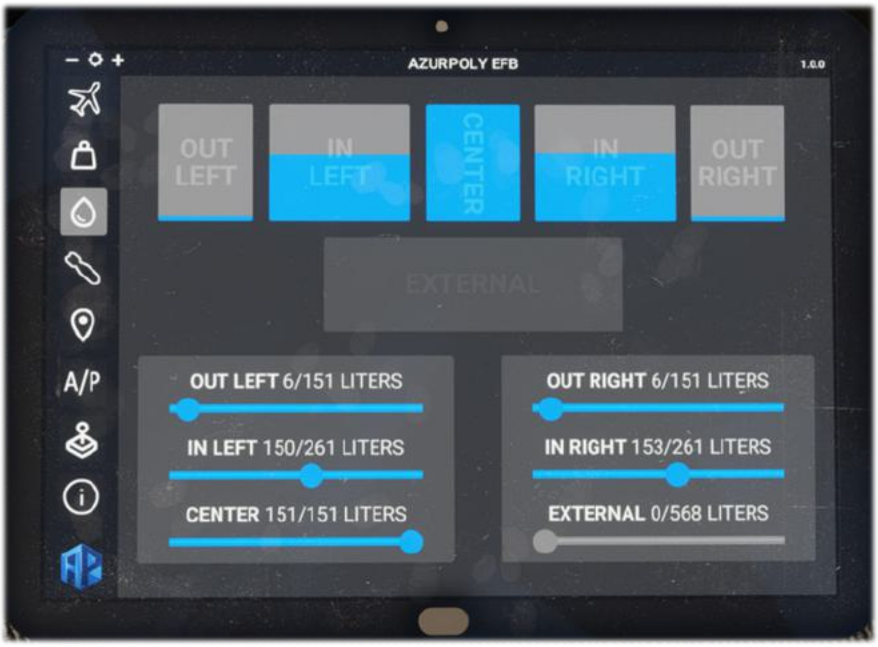
- Smoke button.
- Canopy repair button (in case canopy was ripped off during flight).
- Tire pressure setting.



10.3\ FUEL

This page shows fuel quantity in each of the five internal tanks plus in external tank, where you can use sliders to update quantity directly. You can achieve the same by using default fuel menu.

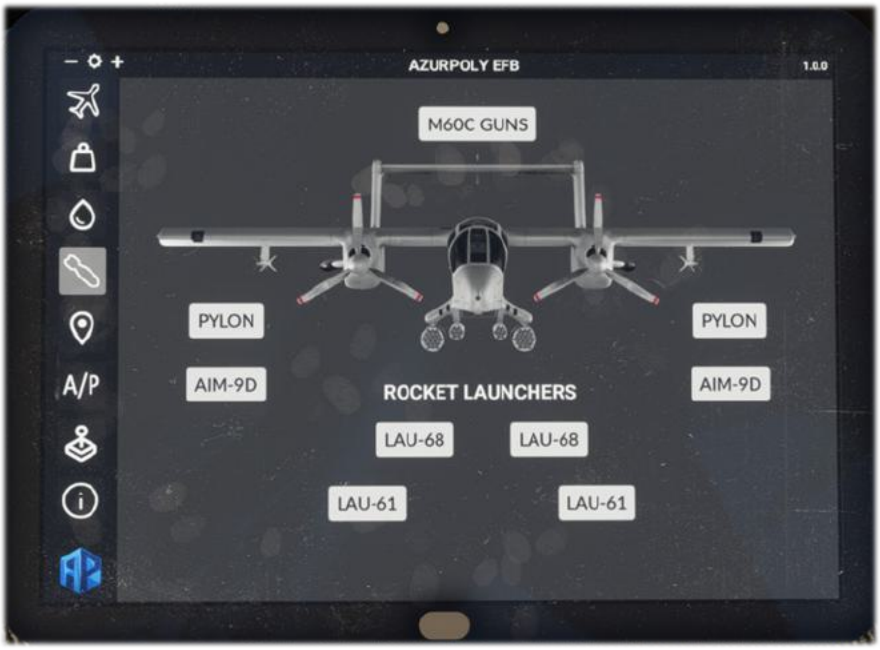
Click on external tank box in order to add it or remove it from the aircraft.



10.4\ WEAPONS

This menu is available if you are flying the OV-10A variant (OV-10B does not carry weapons).

As explained in external stores section, weapons cannot be used if you bought our product on the Marketplace. In order to use them, you need to install the patch available on our website (PC users only). Then you are able to display or hide the various weapons available on the aircraft.

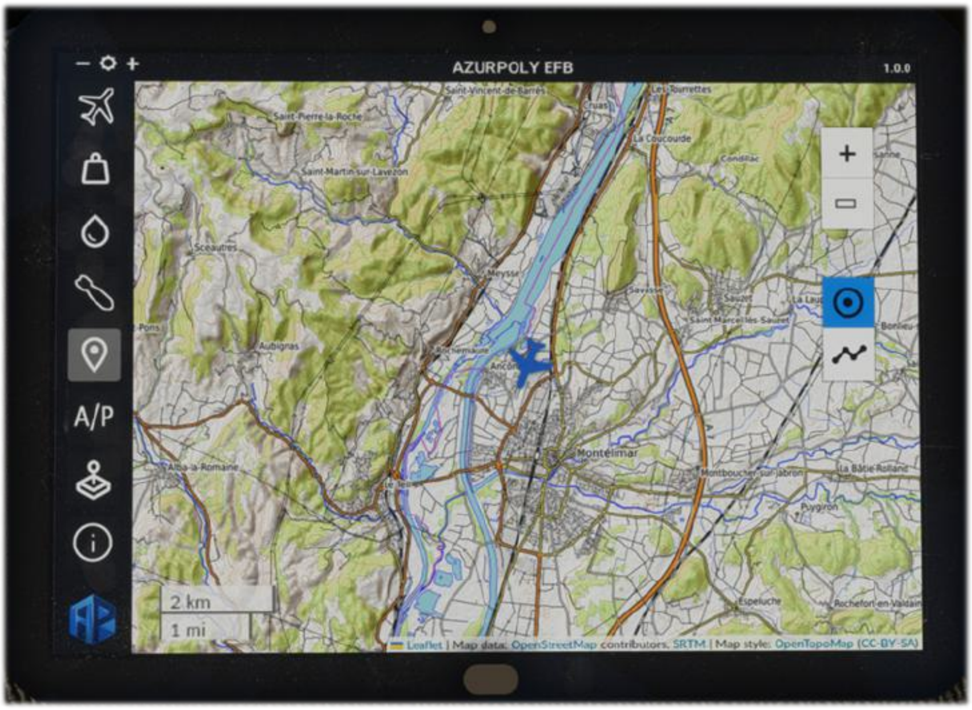


10.5\ MAP

This menu consists of a map showing current aircraft position.

Different controls on the right part allow to interact with the map:

- Zoom buttons.
- Button to stop auto centering to aircraft position.
- Trajectory button to show or hide aircraft path.



10.6\ AUTOPILOT

As the aircraft does not have any autopilot, you can use this page instead.

Clicking on top AUTOPILOT button allows to switch autopilot master on.

When turning ALT or HDG mode on, current altitude/heading will be used by default, and you can change the values with ⊕ and ⊖ buttons, in order to change current altitude or heading.

A precise vertical speed can be set during climb/descent with the value below VS button. As long as ALT mode is enabled, you cannot enable VS mode in standalone but only choose your vertical speed to go to the desired altitude.

10.7\ CONTROLLER SETTINGS

As mentioned in engines section, power levers and condition levers can be bound to controller axis.

You can manage axis settings from this page depending on your flight controllers and personal preferences.

You can choose between two options for power lever axis:

- Use the axis for positive throttle zone only, and switch to ground start/reverse zone using toggle buttons (default).
- Use the single axis for all positions between full reverse and full forward.

In case you are using second option, you can set GROUND START and FLIGHT IDLE positions on the axis, using keyboard input or a button to set value to current axis position.

If condition levers are bound to an axis, you can also set NORMAL FLIGHT and FUEL SHUT-OFF positions on the axis.

Do not forget to click on SAVE button to apply changes.

NOTE: SAME SETTING WILL APPLY TO LEFT AND RIGHT ENGINES.

10.8\ INFO

This menu indicates version of the aircraft currently installed on your machine. A message will be displayed if an update is available.

You can also see your total time spent inside the Bronco.

11\ PROCEDURES

11.1\ REFERENCE SPEEDS

Please note that aircraft weight has a big impact on some reference speeds like stall speed, this table is for indicative purposes only.

Reference speeds	
Stall speed (flaps down)	**70** kts
Stall speed (flaps up)	**80** kts
Rotation speed	**90** kts
Initial climb speed	**130** kts
Approach speed	**100** kts
Best glide speed (no flaps)	**130** kts
Maximum speed in turbulent air (VNO)	**250** kts
Maximum speed with flaps extended	**130** kts

11.2\ CHECKLISTS

We propose in this section detailed checklists, close to the ones used during real aircraft operation.

In addition to this manual, you can find simplified in-game checklists, with essential steps, dynamic validation and cameras management to help you complete each step.

BEFORE STARTING

Covers	**REMOVED**
Battery	**ON**
Seat	**ADJUSTED**
Rudder Pedals	**ADJUSTED**
Flight Controls	**CHECKED**
Fire Detection	**TESTED**
External Power	**IF REQUIRED**
Instruments Power	**INV NO.1**
Fire Detector Warning Lights	**CHECKED**
Radio	**ON**
Attitude Indicator	**CHECKED**
Fuel Quantity Indicator	**CHECKED**
Fuel Quantity	**CHECKED**

STARTING ENGINES

Brakes	**SET**
Propeller	**CLEAR**
Starter	**START**
Wait for 10% RPM	
Condition Lever	**NORMAL FLIGHT**
Wait for 50% RPM	
Oil Pressure	**50 PSI MINIMUM**
Start Ignition Light	**OUT**
EGT/TIT	**815°C MAXIMUM**
Fuel Boost Light	**OUT**
Propeller	**UNLOCK** (1)
Repeat previous steps for other engine	
Generators	**ON**
External Power	**DISCONNECT**
Generator Caution Lights	**OUT**

(1) To unlock propeller, smoothly retard power lever to reverse range, note increase in torque, then return to GROUND START position.

BEFORE TAXI

Instruments Power	**CHECKED**
Trim Select	**ALT**
Trim Operation	**CHECKED**
Trim Select	**NORM**
Compass	**SET**
Radio / Nav	**AS REQUIRED**
Altimeter	**SET**
IFF	**STBY**
Chocks	**REMOVED**

TAXI

Brakes	**CHECKED**
Nose Wheel Steering	**CHECKED**
Flight Instruments	**CHECKED**
Yaw Damper	**CHECK**
Navigation Aids	**CHECKED**

BEFORE TAKEOFF

Trim	**SET**
Aileron Trim Neutral Light	**ON**
Rudder Trim Neutral Light	**ON**
Flaps	**SET**
Navigation Aids	**SET FOR DEPARTURE**
Pitot Heat	**AS REQUIRED**
IFF	**AS REQUIRED**
Anti-Collision Light	**ON**
Feed Tank	**260 TO 280 POUNDS**
Flight Controls	**CHECKED**
Canopy	**CLOSED & LOCKED**

LINEUP

Attitude indicator	**SET, FLAG NOT VISIBLE**
BDHI	**CHECKED**
Condition Levers	**T.O/LAND.**
Power levers	**ADVANCE**
Instruments	**NORMAL INDICATIONS**

AFTER TAKEOFF

Landing Gear	**UP**
Flaps	**UP**

CLIMB

Condition Levers	**AS REQUIRED**
Yaw Damper	**AS REQUIRED**
External Fuel Transfer	**AS APPLICABLE**

CRUISE

Condition Levers	**NORMAL FLIGHT**
Power Levers	**AS REQUIRED**

DESCENT

Approach procedures	**REVIEW**
Cockpit Air/Defrost	**AS REQUIRED**
Altimeter	**SET**
Power Levers	**AS REQUIRED**

BEFORE LANDING

Condition Levers	**T.O./LAND.**
Yaw Damper	**OFF**
Hydraulic System	**CHECK**
Gear	**DOWN**
Flaps	**AS REQUIRED**

AFTER LANDING

Flaps	**UP**
Condition Levers	**NORMAL FLIGHT**
IFF	**OFF**
Anti-collision Light	**OFF**
External Fuel Transfer	**OFF**
Trim	**NEUTRAL**

SHUTDOWN

Parking Brake	**SET**
Radio And Navigation Equipment	**OFF**
Power Levers	**GROUND START**
Condition Levers	**FUEL SHUT-OFF**
Instruments Power	**OFF**
Navigation Lights	**OFF**
Battery	**OFF**

BEFORE LEAVING AIRCRAFT

Wheel Chocks	**IN PLACE**
Parking Brake	**RELEASE**
Canopy	**CLOSED**

12\ PERFORMANCE

12.1\ TAKEOFF

The take-off distance charts provide a means of determining take-off distance under normal or STOL operating conditions, with 20 degrees of flaps. The charts present expected torque, refusal speeds, take-off speeds, ground run distance for various types of runways, with various wind conditions.

These data are based on two-engine operation as a function of aircraft weight.

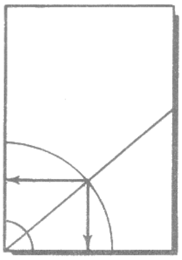
Takeoff distance includes horizontal distance required to take-off plus climb to a 50 feet clearance height.

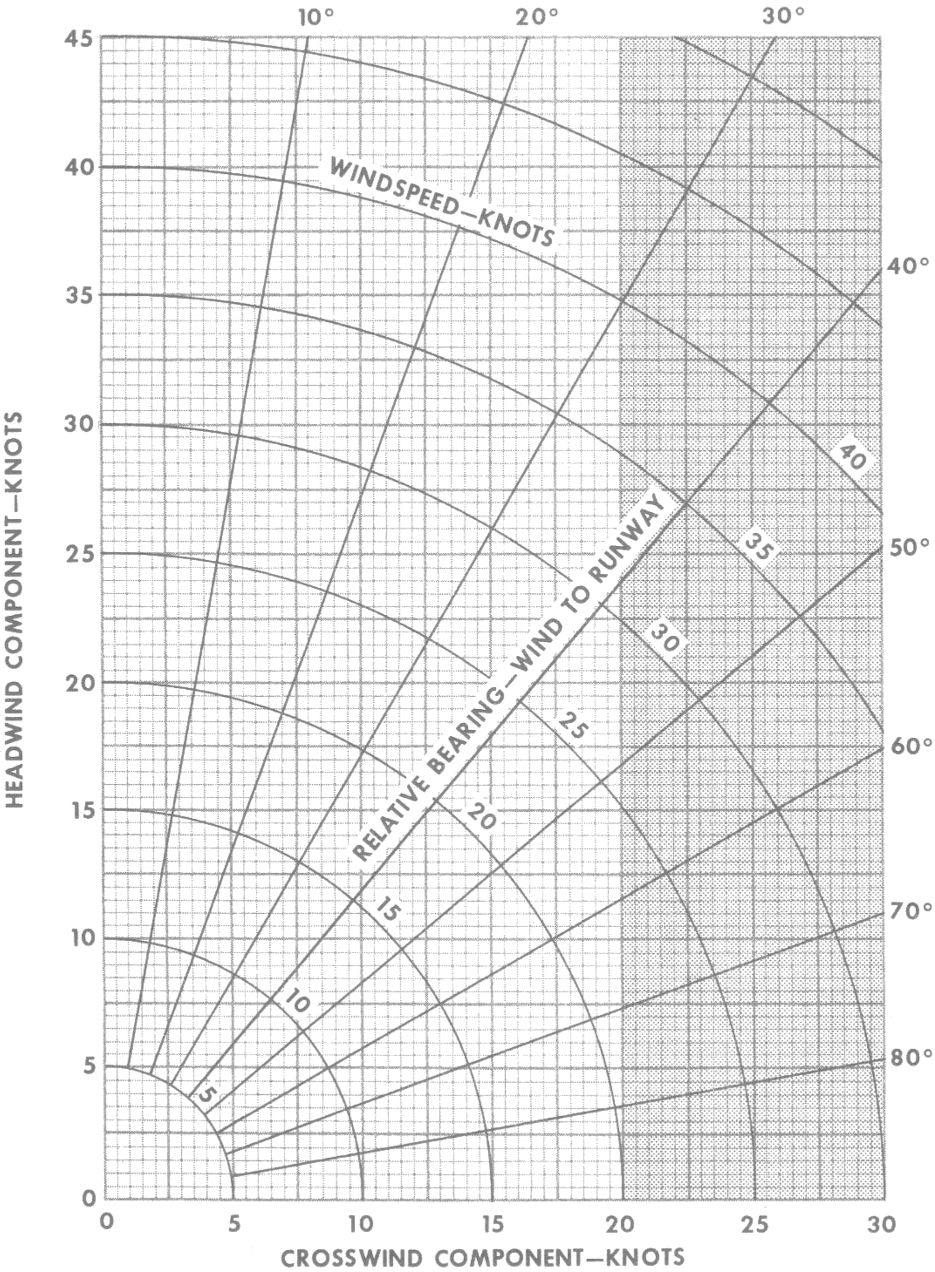
A wind component chart is used to obtain headwind, tailwind, or crosswind components for winds from 0 to 60 knots at angles up to 90 degrees from aircraft heading. Crosswind component limit is 20 knots for take-off and landing.

WIND COMPONENT

CROSSWIND

EXAMPLE:

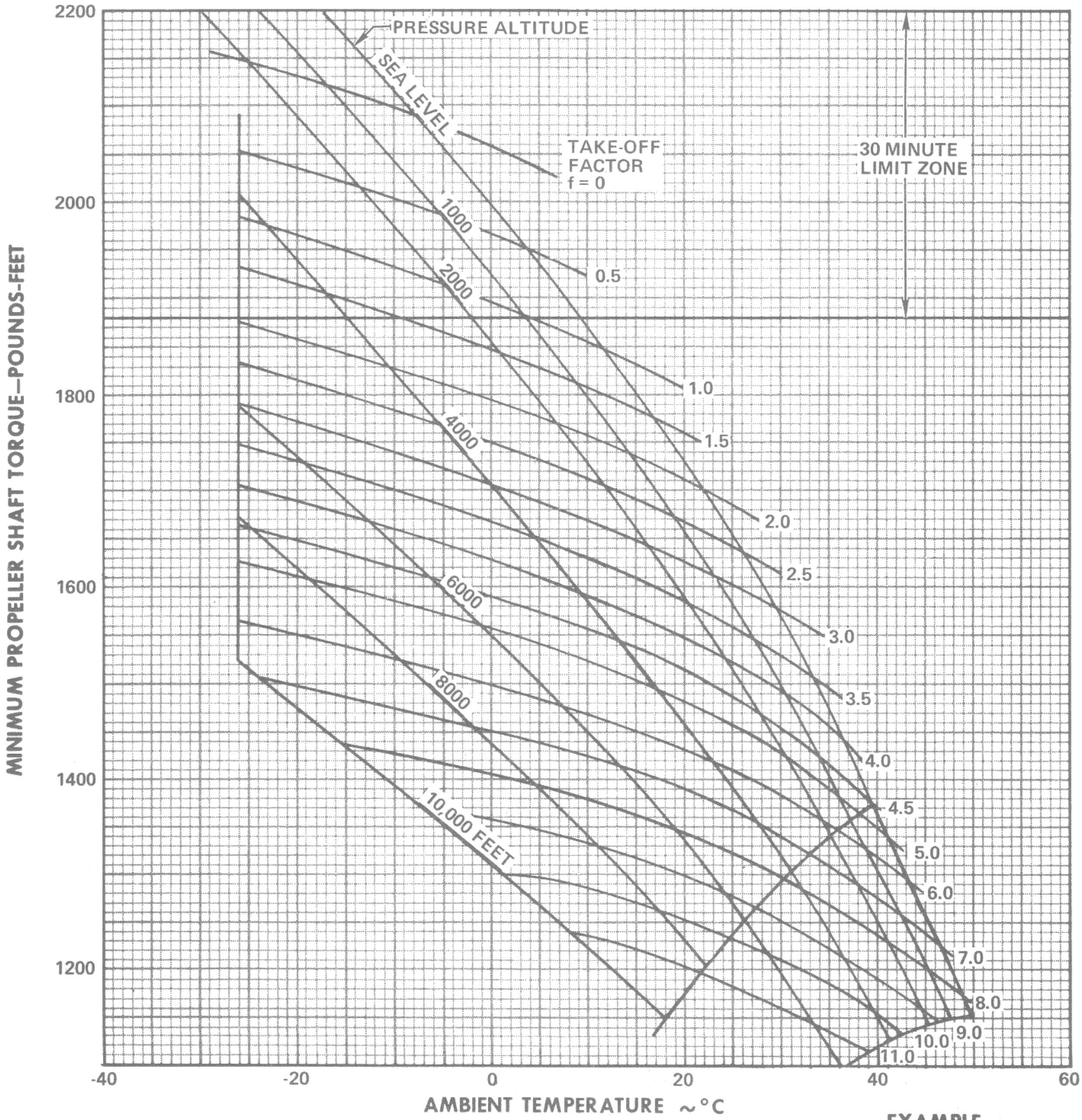




TAKE-OFF DISTANCE

FLAPS 20°

BASED ON: **FLIGHT TEST DATA**
DATA AS OF: 15 JUNE 1969



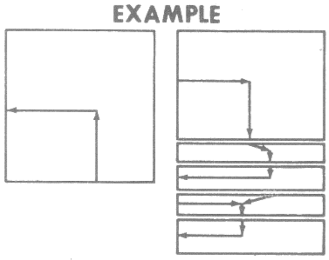
TAKE-OFF SPEED—KNOTS IAS

GROSS WEIGHT (POUNDS)	SPEED
8,000	78
9,000	83
10,000	87
11,000	91
12,000	95
13,000	99
14,000	103

NOTE:

INCREASE GROUND RUN DISTANCE 4% FOR EACH ONE PERCENT INCREASE IN THE RUNWAY SLOPE

EXAMPLE



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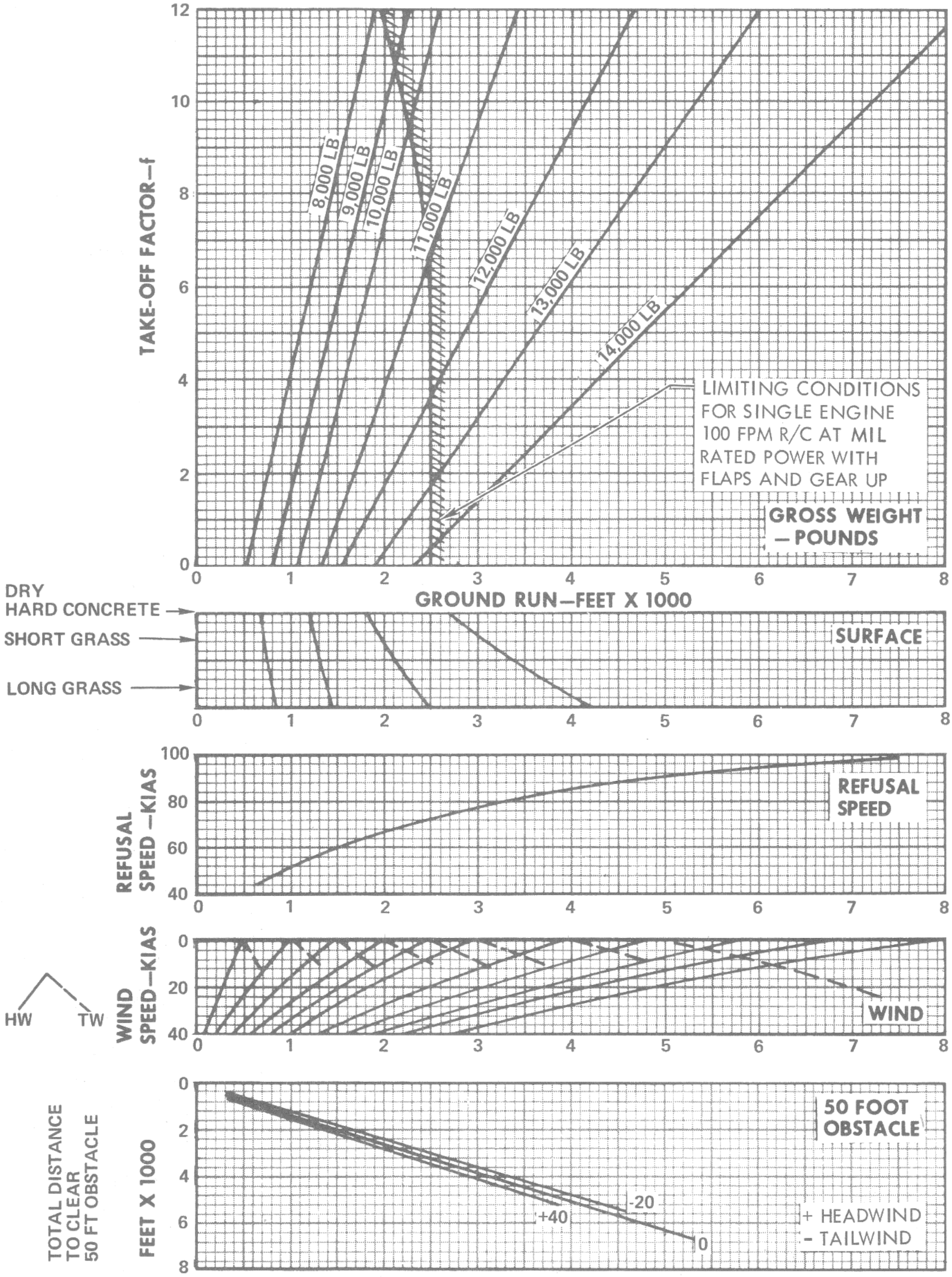


TAKE-OFF FACTOR—f
12
10
8
6
4
2
0
8,000 LB
9,000 LB
10,000 LB
11,000 LB
12,000 LB
13,000 LB
14,000 LB
LIMITING CONDITIONS FOR SINGLE ENGINE 100 FPM R/C AT MIL RATED POWER WITH FLAPS AND GEAR UP
GROSS WEIGHT — POUNDS
0 1 2 3 4 5 6 7 8
GROUND RUN—FEET X 1000
DRY HARD CONCRETE
SHORT GRASS
LONG GRASS
SURFACE
0 1 2 3 4 5 6 7 8
REFUSAL SPEED —KIAS
100
80
60
40
REFUSAL SPEED
0 1 2 3 4 5 6 7 8
WIND SPEED—KIAS
0
20
40
HW
TW
WIND
0 1 2 3 4 5 6 7 8
TOTAL DISTANCE TO CLEAR 50 FT OBSTACLE
FEET X 1000
0
2
4
6
8
50 FOOT OBSTACLE
-20
+40
0
+ HEADWIND
- TAILWIND

12.2\ CLIMB

Those three charts show time to climb, distance covered and fuel required at best climb speed with Military power at various gross weights, drag indexes and ambient temperatures.

MILITARY POWER CLIMB

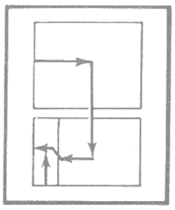
BASED ON: **FLIGHT TEST DATA**
DATA AS OF: 15 JUNE 1969

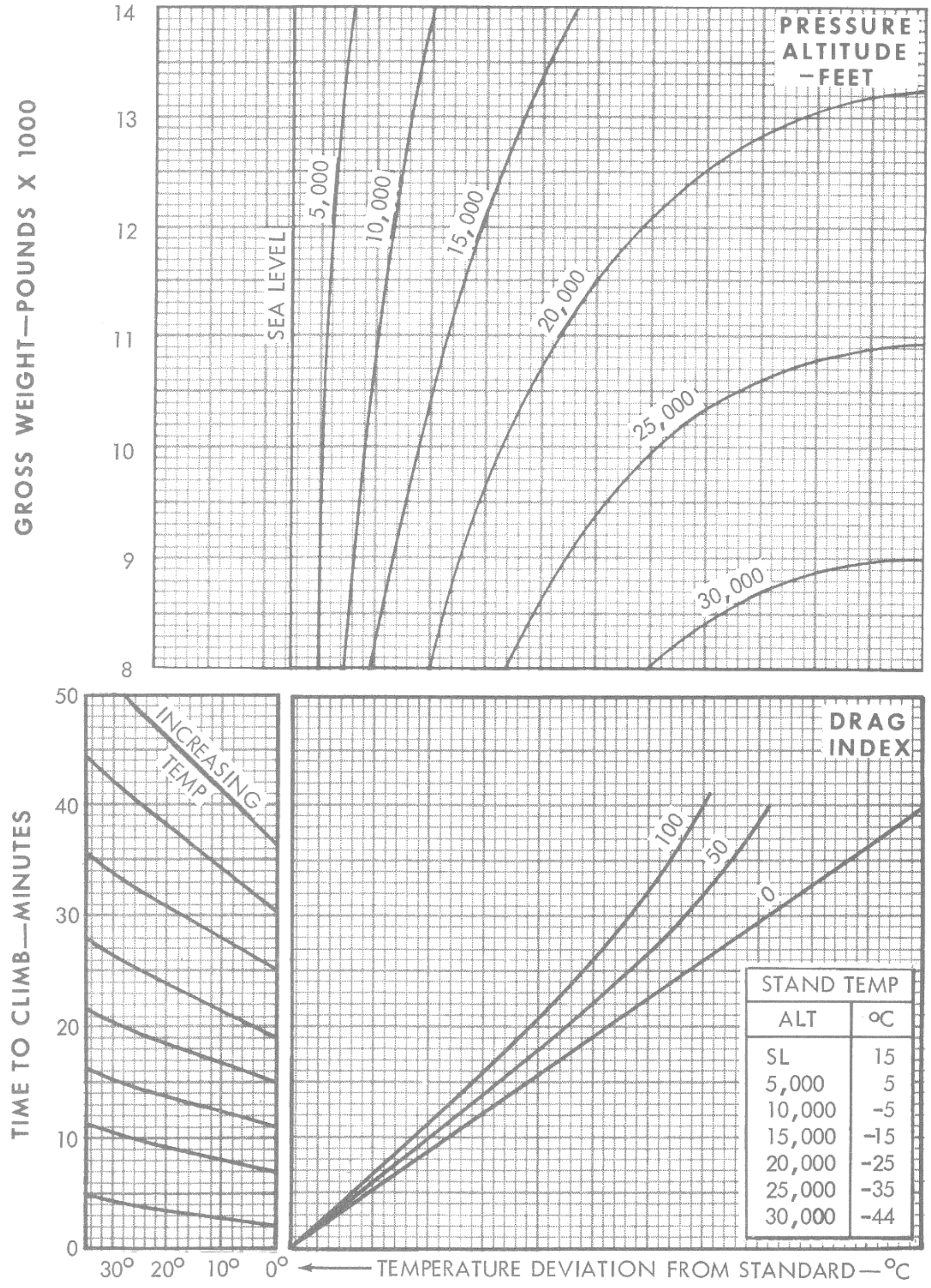
MIL CLIMB TIME

CLIMB SPEED SCHEDULE—KNOTS IAS

ALTITUDE - FT	DRAG 0	50	100
SEA LEVEL	134	127	120
5,000	129	123	116
10,000	125	119	113
15,000	122	117	112
20,000	122	117	112
25,000	119	115	110
30,000	113	109	104

EXAMPLE

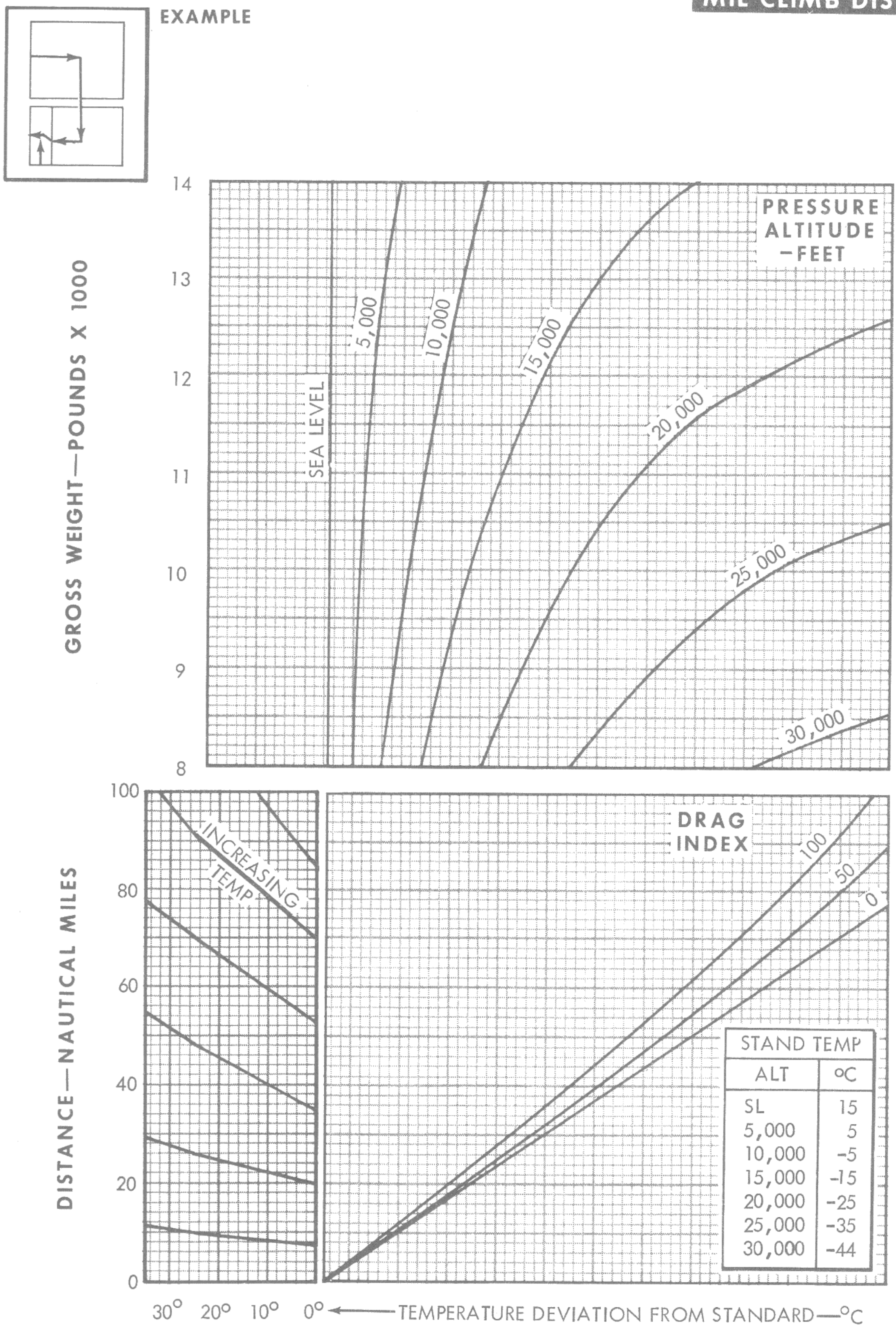




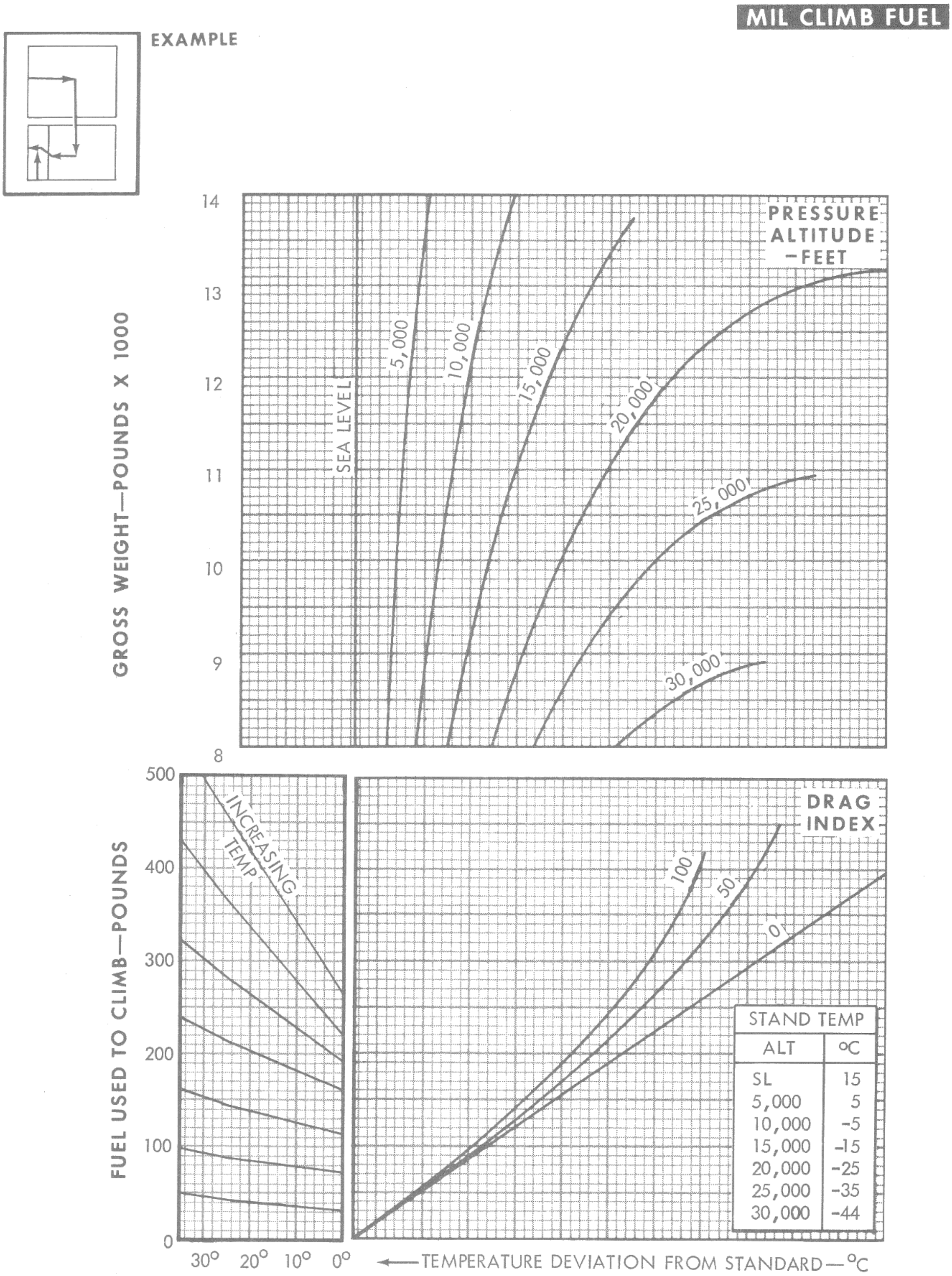
STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	-5
15,000	-15
20,000	-25
25,000	-35
30,000	-44

VA-1-95C

MIL CLIMB DISTANCE



MILITARY POWER CLIMB



STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	-5
15,000	-15
20,000	-25
25,000	-35
30,000	-44

12.3\ CRUISE

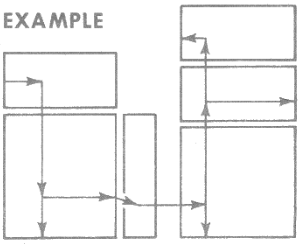
Constant altitude cruise charts are used to determine speeds, fuel and time requirements for navigational flights. An average gross weight may be used for a given leg.

CONSTANT ALTITUDE CRUISE

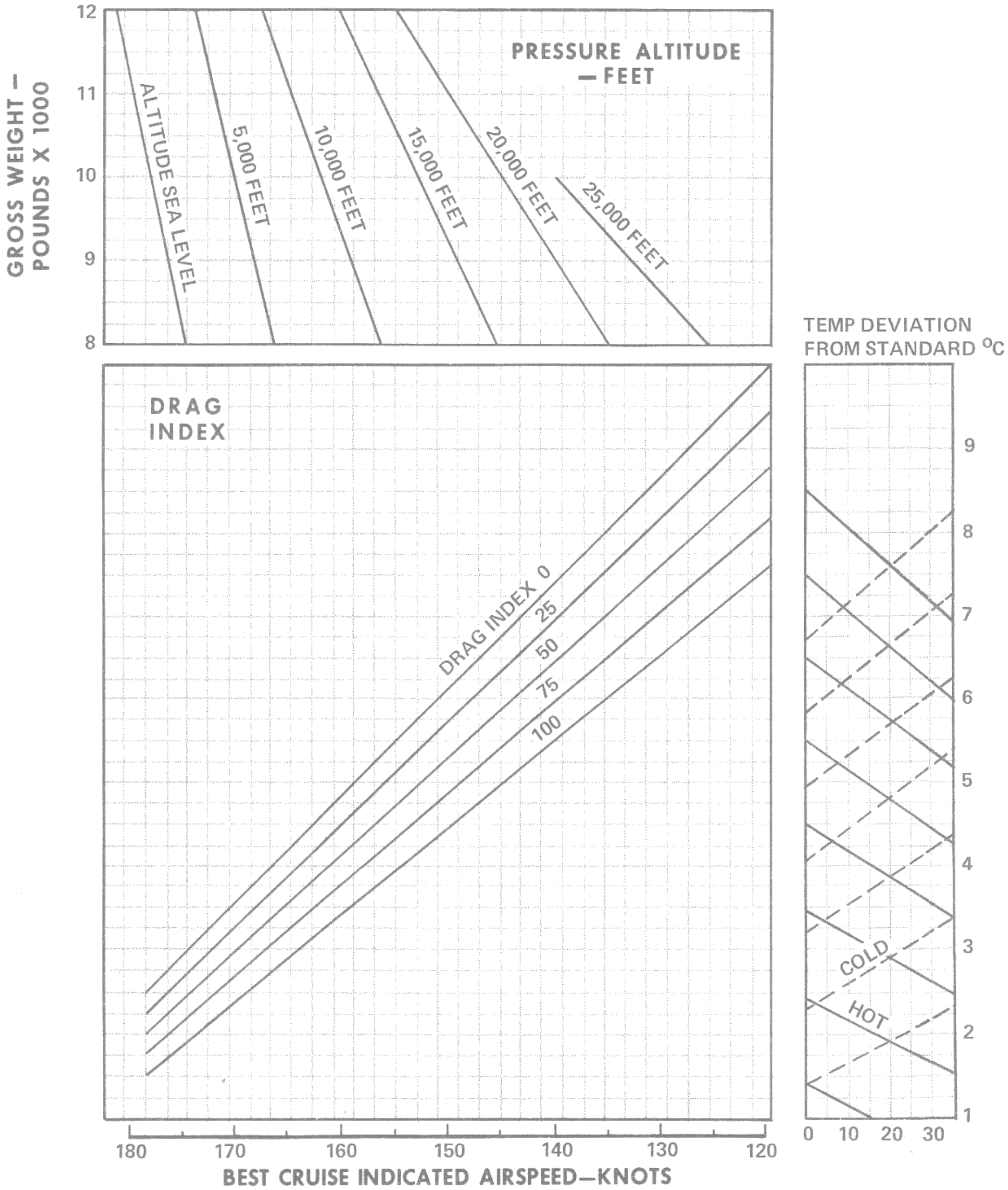
BASED ON: **FLIGHT TEST DATA**
DATA AS OF: 15 JUNE 1969

MAXIMUM RANGE
SPEED, FUEL AND TIME

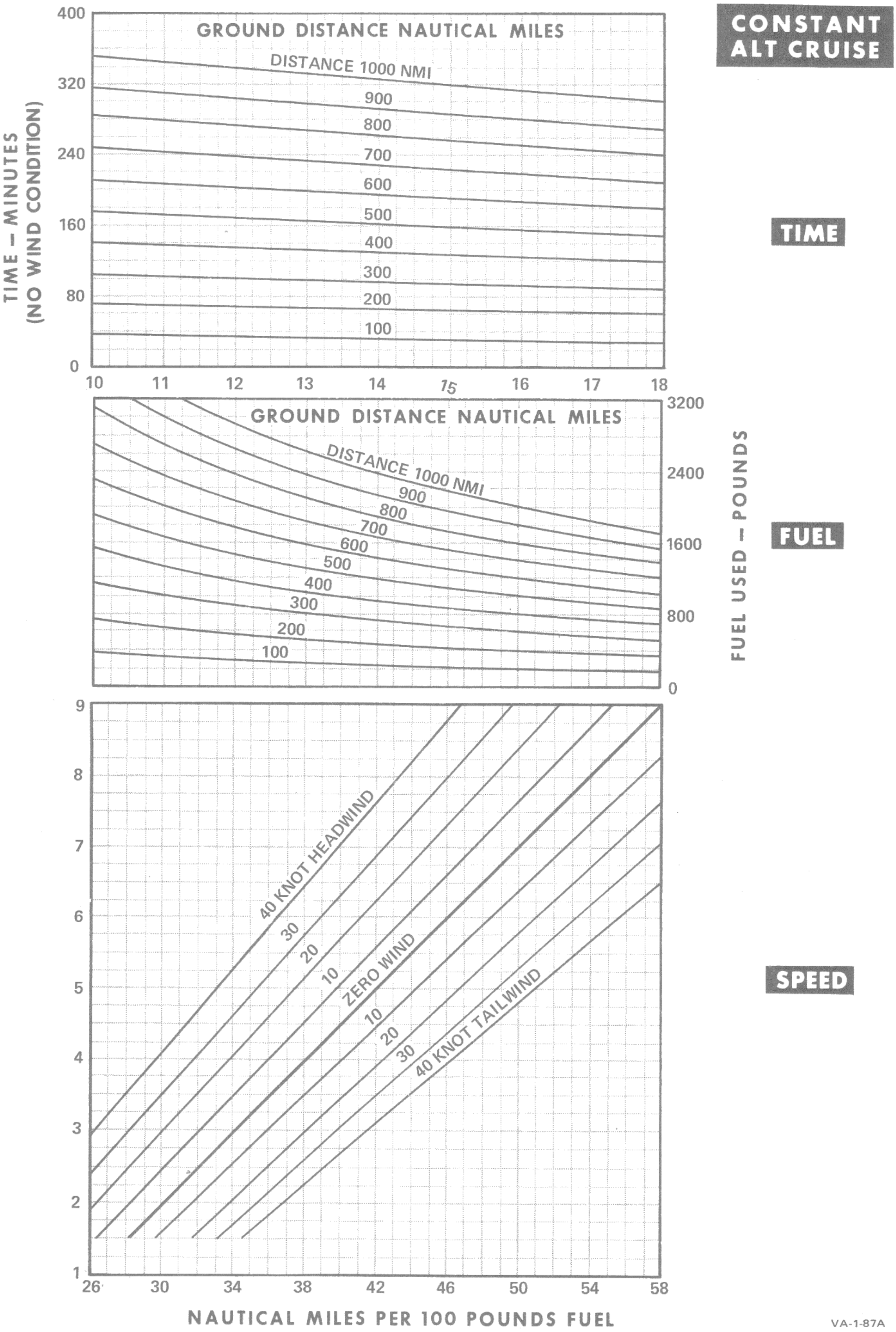
EXAMPLE



STANDARD TEMPERATURF		
ALTITUDE (FT)	°F	°C
S.L.	59	15
5,000	41	5
10,000	23	-5
15,000	6	-15
20,000	-12	-25



VA-1-86C


CONSTANT
ALT CRUISE
TIME
FUEL
SPEED
GROUND DISTANCE NAUTICAL MILES
DISTANCE 1000 NMI
900
800
700
600
500
400
300
200
100
TIME – MINUTES
(NO WIND CONDITION)
0
80
160
240
320
400
10
11
12
13
14
15
16
17
18
FUEL USED – POUNDS
0
800
1600
2400
3200
40 KNOT HEADWIND
30
20
10
ZERO WIND
10
20
30
40 KNOT TAILWIND
1
2
3
4
5
6
7
8
9
26
30
34
38
42
46
50
54
58
NAUTICAL MILES PER 100 POUNDS FUEL
VA-1-87A

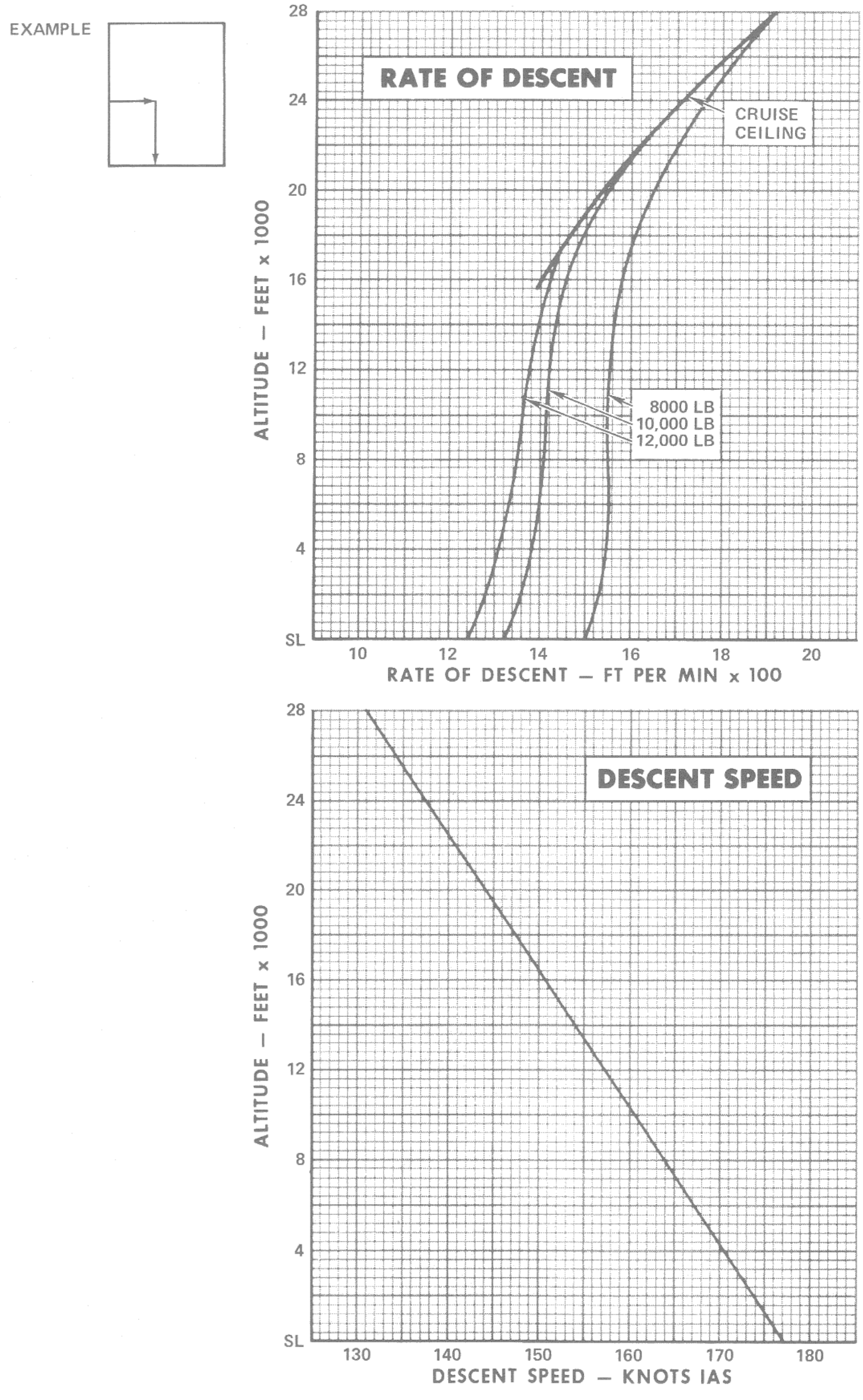
12.4\ DESCENT

Descent data depicts the maximum nautical miles per pound of fuel obtainable during operational descents from altitude down to the landing pattern or target area. Rate of descend and descent speed during a normal descent are determined with both engines at idle power.

NORMAL DESCENT

BASED ON: **FLIGHT TEST DATA**
DATA AS OF: 15 JUNE 1969

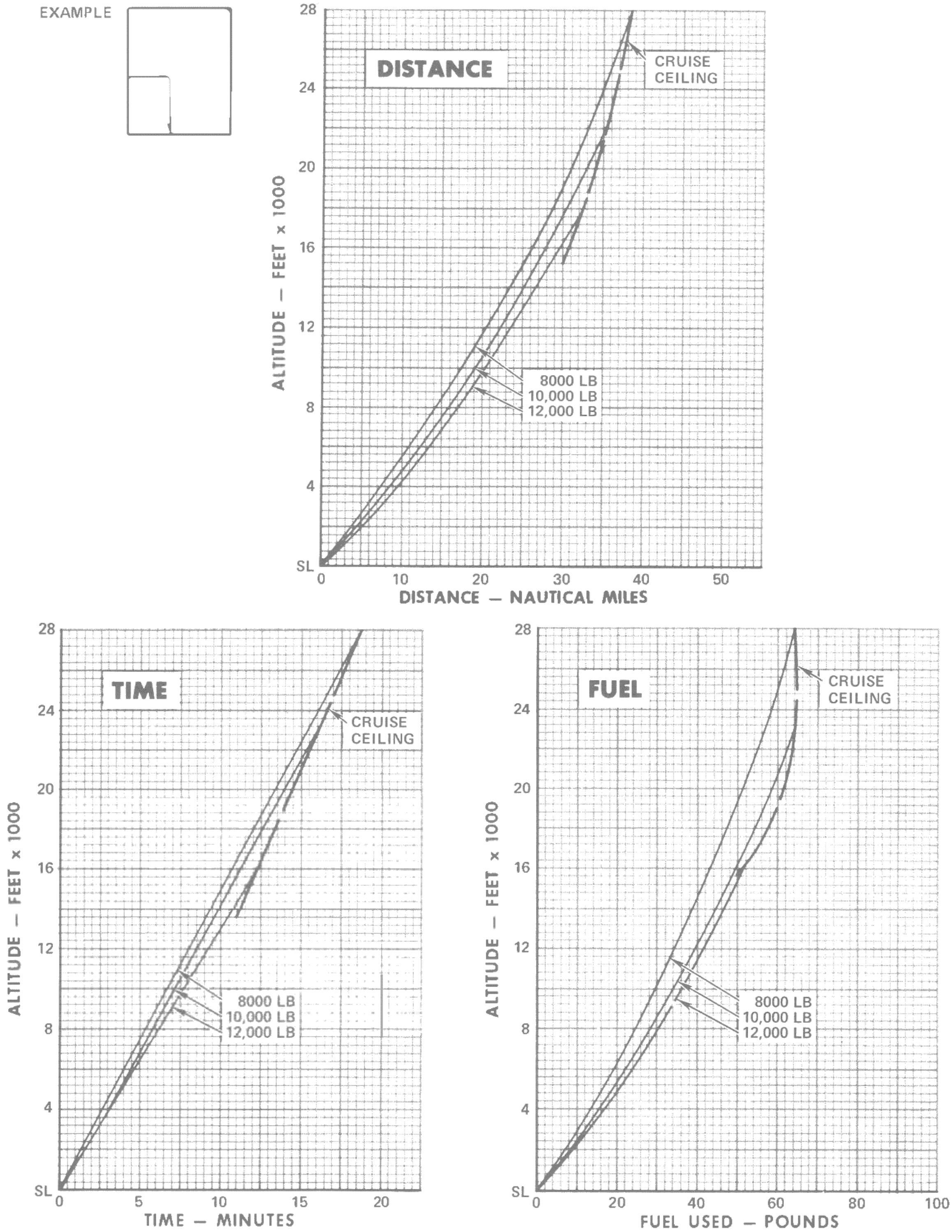
IDLE POWER
FLAPS AND GEAR UP
ENGINES: (2) T-76



NORMAL DESCENT

BASED ON: **FLIGHT TEST DATA**
DATA AS OF: 15 JUNE 1969

IDLE POWER
FLAPS AND GEAR UP
ENGINES: (2) T-76



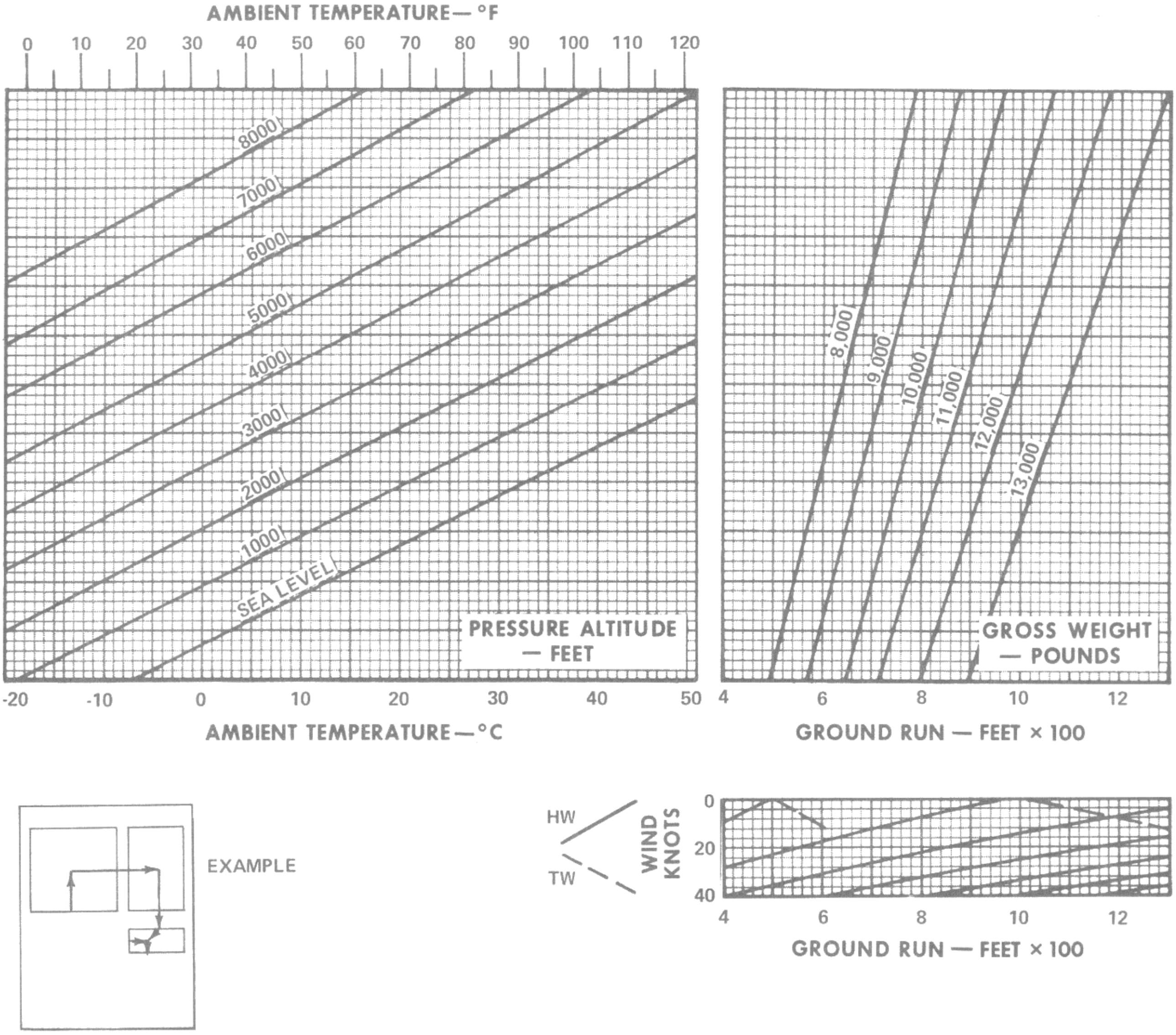
12.5\ LANDING

Landing distance chart determines landing roll for normal performance on hard surface runways for 40° flaps setting, with full reverse thrust.

LANDING DISTANCE

BASED ON: **FLIGHT TEST DATA**
DATA AS OF: 15 JUNE 1969

FULL REVERSE THRUST
DRY HARD RUNWAY
FLAPS 40°



APPROACH AND LANDING SPEED — KNOTS IAS

GROSS WEIGHT (POUNDS)	SPEED
8,000	69
9,000	72
10,000	76
11,000	80
12,000	83.5
13,000	87

NOTE:

1. FOR DISTANCE TO CLEAR 50 FOOT OBSTACLE INCREASE GROUND RUN 70%
2. FOR EACH KNOT ABOVE RECOMMENDED TOUCHDOWN SPEED INCREASE GROUND RUN 25 FEET.
3. FOR LANDING WITHOUT REVERSE THRUST INCREASE GROUND RUN 50%.

VA-1-146A