AVRO

VULCAN

B MK. 2, K.2 & MRR

OPERATIONS MANUAL

Just Flight

AVRO VULCAN B MK. 2, K.2 & MRR

Operations Manual

Please note that Microsoft Flight Simulator must be correctly installed on your PC prior to the installation and use of this Vulcan B Mk. 2, K.2 & MRR simulation.

CONTENTS

INTRODUCTION

The Vulcan B Mk. 2 is a four-engine, delta-wing strategic bomber that saw service in the UK during the Cold War. XM655, on which this add-on is based, was the third-from-last Vulcan to be produced for the Royal Air Force. It was delivered in 1964 and was part of the UK's nuclear deterrent force throughout the 60s and 70s. It is now being preserved by a team of volunteers at Wellesbourne Airfield.

The Vulcan was the second of the V-bombers to enter service, preceded by the Vickers Valiant and followed by the Handley Page Victor. The B.2 was the successor to the earlier B.1, featuring more powerful engines, a larger wing area and improved systems including electronic countermeasures (ECM) and in-flight refuelling capability.

The Vulcan gained fame when it took part in Operation Black Buck, a series of long-range bombing missions during the Falklands War. It was considered the most technologically advanced of the three V-bombers and served with the RAF until its retirement in 1984.

Aircraft specifications

Dimensions

Length	32.3 m (106 ft)
Wingspan	33.8 m (111 ft)
Height (to top of tail)	8.3 m (27 ft)
Wing area	368.4 m^2 (3,965 ft^2)

Engine

Type	4 x Bristol Siddeley Olympus 201 turbojets (or 4 x Bristol Siddeley Olympus 301 turbojets)
Power	Each rated at 17,000 lb static thrust (or each rated at 20,000 lb static thrust)

Weights and fuel

Empty weight	99,630 lb (45,191 kg)
Normal maximum all-up weight	205,000 lb (92,986 kg)
Fuel capacity (without bomb bay tanks)	74,080 lb (9,260 gallons)

Performance

Maximum level speed (sea level)	Mach 0.75 (528 MPH)
Maximum cruising speed (55,000 ft)	Mach 0.95 (627 MPH)
Service ceiling	64,960 ft
Range (internal fuel)	1,710-2,300 miles
Range (ferry)	4,750 miles

Paint schemes

The Vulcan is supplied in 19 paint schemes:

B.2

- XH534 (230 OCU, RAF Coltishall)
- XH538 (No.1 Group, RAF Strike Command, USAF Giant Voice Bombing Competition 1979)
- XH558 (RAF Vulcan Display Flight, 1992)
- XH558 (Vulcan To The Skies, 2010)
- XH562 (9 Squadron, RAF Akrotiri, Kiwi roundels)
- XL361 (617 Squadron, RAF Scampton, anti-flash white)
- XL426 (83 Squadron, RAF Scampton, anti-flash white)
- XL426 (Vulcan Restoration Trust)
- XM600 (9 Squadron, RAF Cottesmore)
- XM607 (44 Squadron, RAF Waddington, Black Buck)
- XM607 (44 Squadron, RAF Waddington, Red Flag 77-9)
- XM655 (35 Squadron, RAF Scampton)
- XM655 (XM655 Maintenance and Preservation Society)

K.2

- XH558 (50 Squadron, RAF Waddington)
- XJ825 (50 Squadron, RAF Waddington)
- XL445 (50 Squadron, RAF Waddington)
- XM571 (50 Squadron, RAF Waddington)

MRR

- XH534 (27 Squadron, RAF Scampton)
- XH560 (27 Squadron, RAF Scampton)

INSTALLATION, UPDATES AND SUPPORT

You can install this Vulcan software as often as you like on the same computer system:

1. Log in to your Account on the Just Flight website.
2. Select the 'Your Orders' button.
3. A list of your purchases will appear and you can then download the software you require.

Accessing the aircraft

To access the aircraft:

1. Click on 'World Map'.
2. Open the aircraft selection menu by clicking on the aircraft thumbnail in the top left.
3. Use the Search feature or scroll through the available aircraft to find the 'Just Flight Avro Vulcan'.
4. After selecting the aircraft, use the 'Liveries' menu to choose your livery.

Uninstalling

To uninstall this product from your system, use one of the Windows App management features:

Control Panel > Programs and Features

or

Settings > Apps > Apps & features

Select the product you want to uninstall, choose the 'Uninstall' option and follow the on-screen instructions.

Uninstalling or deleting this product in any other way may cause problems when using this product in the future or with your Windows set-up.

Updates and Technical Support

For technical support (in English) please visit the Support pages on the Just Flight website.

As a Just Flight customer, you can get free technical support for any Just Flight product.

If an update becomes available for this aircraft, we will post details on the Support page and we will also send a notification email about the update to all buyers who are currently subscribed to Just Flight emails.

Regular News

To get all the latest news about Just Flight products, special offers and projects in development, subscribe to our regular emails.

We can assure you that none of your details will ever be sold or passed on to any third party and you can, of course, unsubscribe from this service at any time.

You can also keep up to date with Just Flight via Facebook and X (formerly Twitter).

SYSTEMS GUIDE

The Vulcan B Mk. 2 is a delta-wing, all-metal aircraft. It is powered by four Olympus 301 engines, each developing 20,000 lb static thrust at sea level in ISA conditions. The aircraft is capable of air-to-air refuelling and is fitted with a ram air turbine (RAT) and an airborne auxiliary power plant (AAPP) for emergency electrical supplies.

The aircraft is operated by a crew of five:

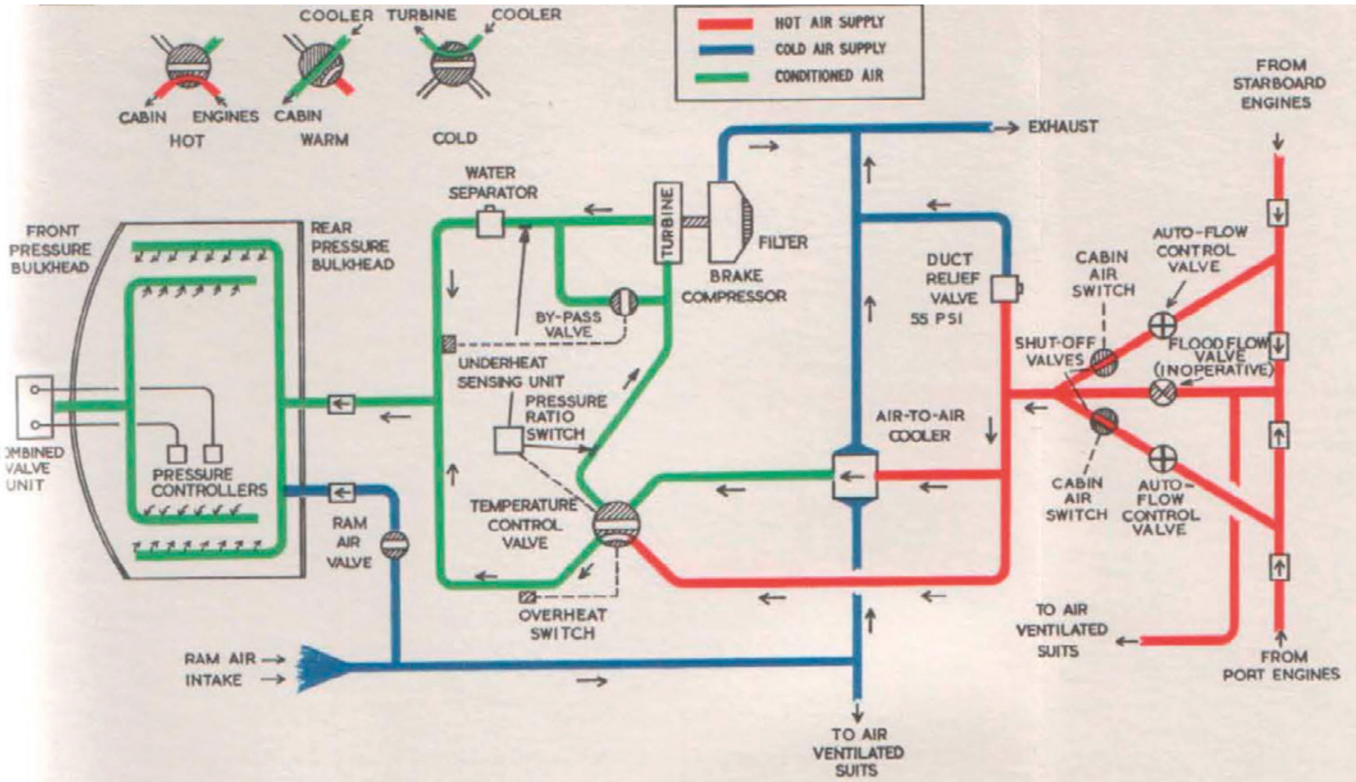
- Captain
- Co-pilot
- Airborne Electrical Operator (AEO)
- Navigator/plotter
- Navigator/radar

The two pilots are seated side by side on ejector seats on a raised platform at the front of the cabin, referred to as the cockpit. The rear crew members are behind the two pilots, facing aft. This simulation features only the cockpit area.

Air conditioning

The cabin air conditioning and pressurisation system provides a means of maintaining comfortable temperatures and pressures within the crew compartment. Hot pressurised air is fed from the engine compressors, cooled by cold ram air and a cooling turbine, and then distributed throughout the cabin via ducting.

The temperature of the conditioned air is controlled by varying the proportion of hot air which flows through or bypasses the air cooler or the cooling turbine. The cabin pressure is determined by the amount of air allowed to flow out of the crew compartment. Pressurisation can be at two alternative levels: cruise or combat. The controls for cabin heating and pressurisation are grouped together on the right console.

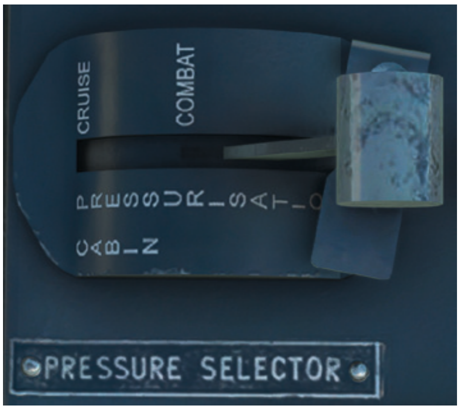


Cabin pressurisation

Two alternative pressurisation settings can be obtained:

- **CRUISE** – cabin altitude is maintained at 8,000 ft until the maximum differential pressure of 9 PSI is reached at approximately 47,000 ft, after which cabin altitude increases proportionally.
- **COMBAT** – cabin altitude is maintained at 8,000 ft until the maximum differential pressure of 4 PSI is reached at approximately 19,500 ft, after which cabin altitude increases proportionally.

An EMERGENCY DECOMPRESSION switch on the left console allows for decompression of the cabin in an emergency.



Cabin pressure is controlled by the three-position CABIN PRESSURISATION CRUISE / COMBAT / NO PRESSURE switch. With the switch at NO PRESSURE, pressurisation does not take place or, if the cabin is already pressurised, moving the switch to NO PRESSURE decompresses the cabin.

Cabin air conditioning and controls

The four ENGINE AIR OPEN/SHUT switches on the right console control the supply of engine air to the flow control valves. They also control the supply of engine air to the anti-icing systems and bomb bay heating.

The two CABIN AIR OPEN/SHUT switches open the shut-off valves, allowing the engine air to pass to the air conditioning unit. One switch controls the starboard supply and the other the port supply. When a switch is at OPEN, the flow valve automatically regulates the volume of air passing to the system.

Cabin temperature can be controlled automatically or manually. Automatic or manual control is selected by a four-position switch. When the switch is moved to the AUTO position, the temperature is automatically controlled according to the setting of the TEMP. SELECTOR AUTO rotary control. If manual control is required, the switch is moved to the down position and then moved and held either forward to the COLD position or aft to the HOT position until the desired temperature is obtained. The switch is spring-loaded from both of these positions to the centre (neutral) position. An indicator shows the position of the temperature control valve.

The ram air valve is controlled by a three-position guarded SHUT/OPEN switch, spring-loaded to the central (neutral) position. An indicator shows the position of the valve.

An A.A.P.P. BLEED FOR CABIN CONDITION SHUT/OPEN switch is used to provide cabin ventilation on the ground. An override device, operated by an undercarriage microswitch, prevents the use of AAPP bleed in flight. A magnetic indicator is provided beside the switch, showing OPEN, SHUT, or cross-hatch when no electrical power is available.

The air-ventilated suits are supplied from an air conditioning unit which is similar to that used for cabin air conditioning. The main cock in the hot air supply is controlled by a VENT SUIT OPEN/CLOSE switch at the rear of the right console. Temperature and flow controls are provided for each suit on each console.

Operation of cabin air system

Before starting the engines, set the controls as follows:

- Cabin pressure selector – CRUISE
- Auto temperature selector – NORMAL
- Engine air switches – ALL SHUT
- Cabin air switches – BOTH SHUT
- Cabin temperature control switch – NEUTRAL (centre)
- Ram air switch – as required
- Emergency decompression switch – NORMAL (forward)
- Abandon aircraft switch – NORMAL (forward)
- Canopy unlocked indicator – black
- AAPP bleed switch – SHUT

If opened on the ground, the ram air switch should be SHUT before take-off unless the extra cooling is required.

After starting the engines, set all engine air switches OPEN and leave them open for the duration of the flight. Set the port cabin air switch OPEN after starting and for taxiing. OPEN the starboard switch at cruise altitude and SHUT it for descent and landing.

In an emergency, cabin pressure can be released by:

- Rearward movement of the EMERGENCY DECOMPRESSION switch
- Rearward movement of the ABANDON AIRCRAFT switch
- Selecting NO PRESSURE on the pressure selector switch

Windscreen thermal demisting

To demist the inside of the windscreen, hot air is supplied from a duct on each side of the centre panel. Windscreen demisting is controlled by an ON/OFF switch on the co-pilot's instrument panel. When switched ON, current is supplied to the blower and the heater.

Oxygen system

Oxygen is carried in twelve 2,250-litre bottles which are housed in the power compartment and bomb bay. High pressure lines supply the oxygen to the cabin.

The oxygen regulators are at the forward end of the left and right consoles. A mixture of oxygen and air is supplied according to cabin altitude. 100% oxygen is provided automatically above 34,000 ft or can be selected at any height.

The regulators have the following controls:

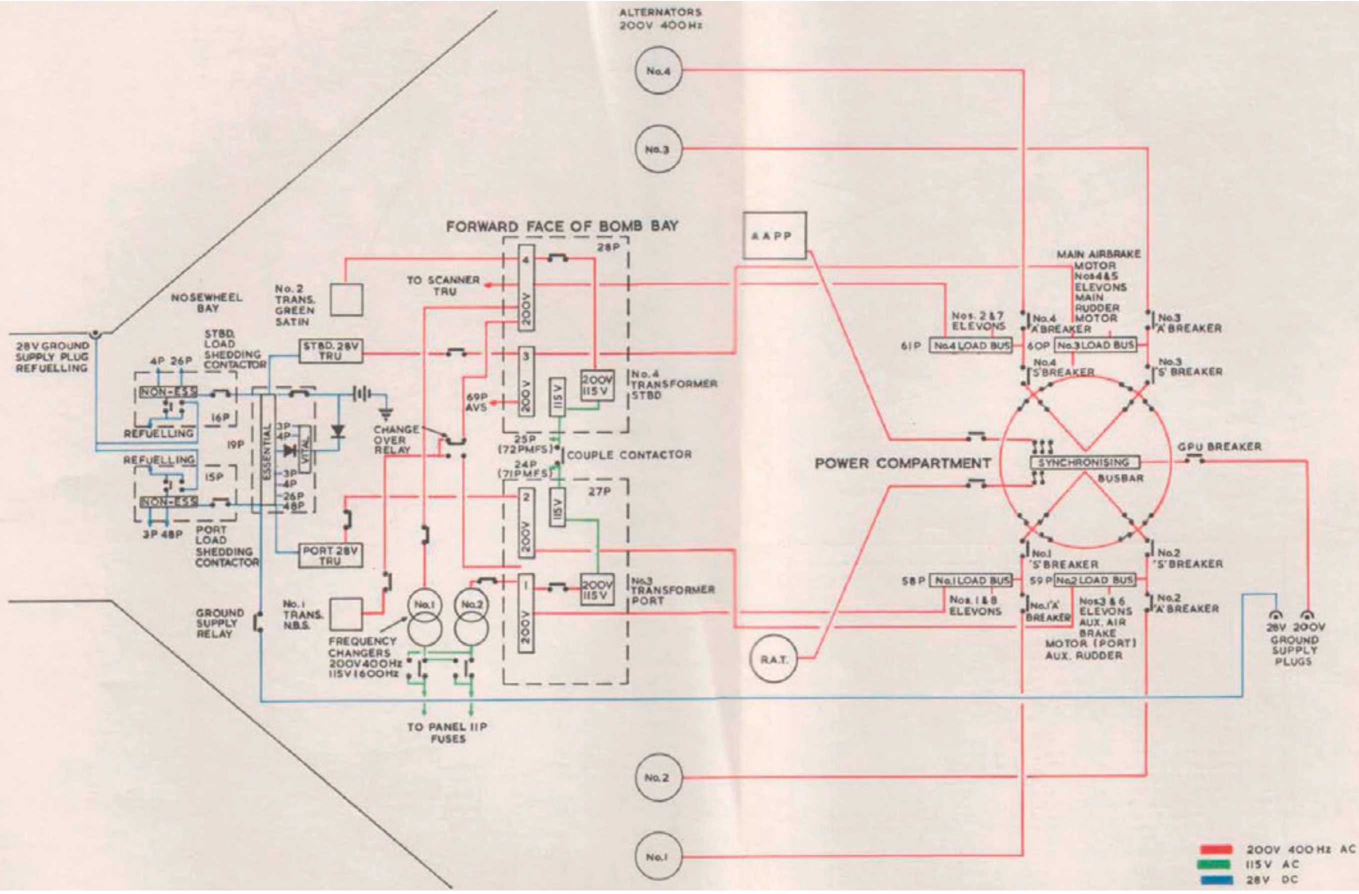
- OXYGEN FLOW INDICATOR magnetic indicator – displays white when oxygen is flowing through the regulator and black when no oxygen is flowing through the regulator.
- NORMAL/100% OXYGEN (air inlet control) – controls the ratio of oxygen to air that is delivered through the regulator. If NORMAL is selected the regulator will automatically vary the ratio to supply the proper mixture to the pilot, dependent on altitude. If 100% is selected the regulator will supply pure oxygen.
- ON/OFF valve – controls the flow of oxygen to the regulator.
- Regulator pressure gauge – displays the current oxygen supply pressure.
- Emergency test button – used to test the supply of oxygen to the mask.

Electrical system

The main electrical system is AC-operated. 200-volt, 3-phase, 400 Hz power is supplied by four 40 kVA alternators, one on each engine.

Current is fed from each alternator to an individual busbar which can be connected to a synchronising ring main busbar for load sharing purposes. From the individual busbars, a number of transformer-rectifier units (TRUs), transformers and frequency changers provide the secondary power supplies.

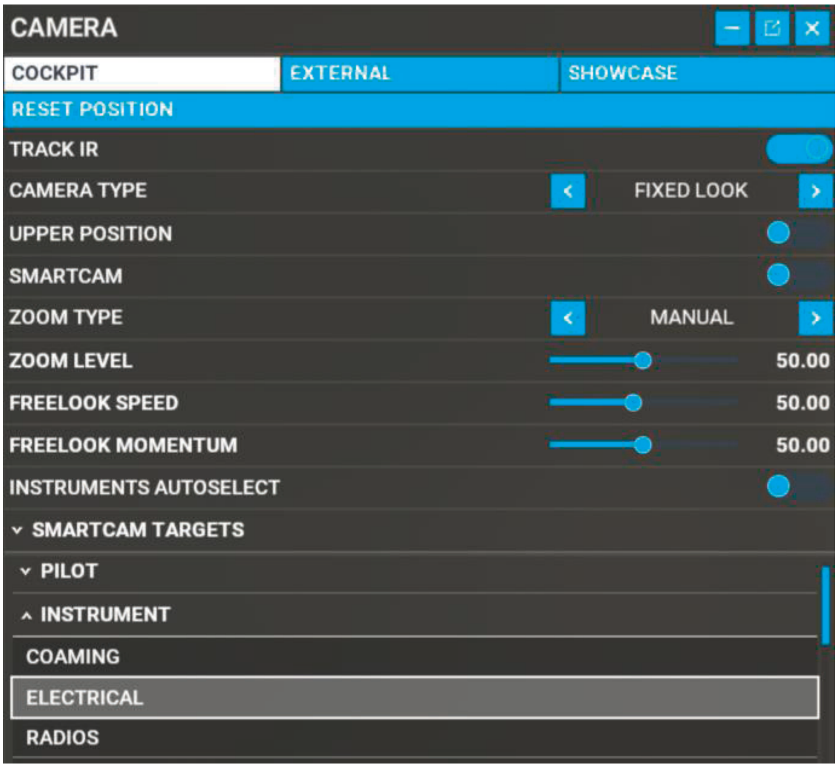
Provision is made for standby supplies in the event of a major AC failure. A ram air turbine (RAT) supplies power primarily at high altitude and an airborne auxiliary power plant (AAPP) supplies power at lower altitudes.



The controls for the electrical system are grouped on the alternator control panel, the secondary supplies panel and the AAPP panel.

These panels are provided in the rear cockpit and can be accessed via multiple methods:

MSFS camera system:



Open the MSFS Camera menu by moving the mouse to the top centre of the screen to open the MSFS toolbar, then click on the camera icon. With the MSFS Camera menu open, the panel cameras can be selected by going to COCKPIT, INSTRUMENT and then selecting ELECTRICAL. To return to the forward cockpit, either repeat the above process and select a COCKPIT camera, or press the [F] key on your keyboard to reset the camera back to the default position.

Panel screws:

Hidden clickspots are provided on screws on the main instrument panel and at the bottom of the rear cockpit panels to swap the camera between the relevant views.

EFB camera controls:

Various camera positions can be accessed by clicking on the respective box at the bottom of the EFB's Aircraft page. The EFB remains at all four cockpit positions. In the AEO and Navigator's position, the EFB is located to the side of the panel and can be brought into view by clicking on the EFB's bezel.

Alternators

Each alternator provides 200-volt, 3-phase, 400 Hz power.

Alternator supplies are controlled by two circuit breakers. With the alternator (A) breaker closed, the alternator feeds its own busbar. With the synchronising (S) breaker and the A breaker closed, the alternator supplies its own busbar and the synchronising busbar.

The A and S breakers are arranged so that if the A breaker is opened, the S breaker is normally closed, thus ensuring an alternative power supply to the individual busbar via the synchronising busbar. The S breaker normally opens before the A breaker is closed. S breakers can be closed in order to parallel two or more alternators on the synchronising busbar.

Each load busbar supplies approximately a quarter of the total loads, and the PFC loads are divided between the four busbars.

The alternator control panel features the following controls and indicators:

- Voltmeter and frequency meter for the selected incoming alternator.
- RAT and AAPP test push-buttons, used to obtain the readings for these supplies on the meters.
- Alternator selector switch, incorporating a push-button to facilitate synchronisation of alternators.
- EXTRA SUPPLIES TRIP push-button, used to trip any extra supply (RAT, AAPP, 200-volt ground supply) from the synchronising busbar.
- Mimic diagram of the 200-volt system. The diagram incorporates a voltmeter and a frequency meter to show supplies at the synchronising busbar, magnetic indicators which show continuity when an S breaker is closed and amber lights to show when an alternator is not connected to its own busbar.
- Magnetic indicators for the RAT and AAPP show continuity when they are connected to the synchronising busbar.
- Centrally positioned red alternator failure warning light (duplicated on the centre instrument panel) which illuminates steadily if one alternator fails and flashes if two or more fail.
- AAPP ON push-button.
- Beside each S breaker indicator is an alternator ISOLATE button.
- Beside each amber light is an alternator RESET button.
- NON-ESSENTIAL SUPPLIES TRIP/RESET switch, spring-loaded to the central (guarded) position. This switch can be used to trip non-essential supplies without releasing the RAT and to reset non-essential supplies once power has been restored.
- Four kW/kVAR meters, one for each alternator; these normally read kW with a centrally positioned button labelled PUSH FOR KVAR to read kVAR.
- Four ON/OFF switches, one for each alternator.

When an engine is running, its alternator is brought on line as follows:

1. Check, by means of the alternator selector switch, that the alternator voltage and frequency are within 115 ±5 volts and 400 ±4 Hz.
2. When the alternator is running correctly, set its alternator switch ON. Check that the S breaker opens, the A breaker closes (amber light out) and the kW/kVAR meter registers the load, indicating that the alternator is feeding its busbar.
3. Whenever there is no supply on the synchronising busbar, it is arranged by means of a voltage pick-up unit that the No.2 alternator S breaker closes automatically.
4. To connect an alternator to the synchronising busbar, select the appropriate alternator on the selector switch and then press in the switch until the magnetic indicator shows continuity. To take an alternator off the synchronising busbar, press its ISOLATE button.
5. For take-off, the AAPP is connected to the synchronising busbar and is normally closed down at 20,000 ft. If the climb is continued, No.4 alternator is connected to the synchronising busbar. For low-level flight or descent below 20,000 ft, No.3 alternator is substituted for No.4 on the synchronising busbar. After landing, the AAPP is connected to the synchronising busbar at 5,000 ft.

Ram air turbine (RAT)

A ram air turbine, housed in the underside of the port air intake, can be lowered into the airstream to provide power for electrical services in an emergency. The RAT drives a 22 kVA alternator which supplies 200-volt, 3-phase, 400 Hz power to the synchronising busbar. The electrical supplies should not be used below 20,000 ft.

When the pilot pulls the RAT release toggle, the RAT releases into the airstream and all non-essential loads are shed automatically, resulting in a cartridge start of the AAPP. The RAT is ready to supply loads within two seconds. Speed should be maintained above M0.85 or 250 knots. The output can be checked on the alternator control panel either by pressing the RAT TEST push-button or, if the RAT is on the synchronising busbar, by reading the voltage and frequency from the synchronising busbar meters.

The RAT output cannot be connected to the synchronising busbar unless No.2 alternator A breaker is open, the RAT voltage is above 180 volts and there is no supply on the synchronising busbar. The RAT is automatically disconnected from the synchronising busbar if No.2 alternator or the AAPP is brought on line.

Once the RAT has been released, it cannot be retracted again in flight. Reload the aircraft or restart the flight to return the RAT to the stowed position.

Airborne auxiliary power plant (AAPP)

The AAPP consists of a gas turbine driving a 40 kVA alternator in a bay aft of the starboard wheel bay. It can provide a 200-volt supply for use in an emergency or for use on the ground when an external power unit is not available. On the ground it can provide bleed air to the cabin air conditioning and the air-ventilated suits.

The AAPP supplies 200-volt, 3-phase, 400 Hz power. It is used as a standby electrical supply and can be connected to any individual busbar via the synchronising busbar.

The AAPP may be started electrically or by a cartridge. Whenever the non-essential services are tripped, either by operation of the RAT release or by selection of the NON-ESSENTIAL SUPPLIES TRIP/RESET switch to TRIP, a cartridge start is triggered. Following RAT release, the non-essential services may be RESET, in which case the electrical method of starting the AAPP is restored. Cartridge starting of the AAPP should not be used on the ground.

Controls

The AAPP controls are on the alternator control panel and the AAPP panel.

Alternator control panel

- AAPP TEST push-button for checking incoming voltage and frequency
- AAPP ON push-button for bringing the AAPP alternator onto the synchronising busbar. The AAPP is prevented from being connected to the synchronising busbar when No.1, 3 or 4 alternators are connected. If the No.2 alternator, the GPU or the RAT are supplying the busbar, pressing the AAPP ON button disconnects them and allows the AAPP alternator to be connected.

AAPP panel

- JPT gauge
- Oil pressure gauge
- Fuel level magnetic indicator, which shows HIGH when the AAPP tank contains 8 gallons or more, LOW when the tank contains less than 2 gallons and black when the fuel is at an intermediate level or when no electrical power is available.
- START push-button, incorporating an amber light to indicate that the oxygen valve is open.
- L.P. COCK OPEN/SHUT switch
- H.P. COCK OVERRIDE switch, spring-loaded to OPEN
- IGNITION ISOLATION switch, spring-loaded to ON
- FIRE warning light and FIRE TEST push-button
- OXYGEN & RELIGHT ON/OFF switch to provide oxygen enrichment for an electrical start above 15,000 ft, to override a selected cartridge and achieve an electrical start to provide a relight facility.
- Split two-pole ON/OFF MASTER SWITCH

Operation

Cartridge starting:

1. When the RAT release toggle is pulled, or the NON-ESSENTIAL SUPPLIES switch is selected to TRIP, the AAPP start circuit is selected to cartridge.
2. Switch ON the master switch.
3. Press the START button.
4. Confirm that the oxygen light illuminates.
5. Check that the JPT, oil pressure, voltage and frequency are within limits.

Electrical starting:

1. If the non-essential busbars are live, indicated by the load shedding indicators showing a horizontal line, or if the non-essential busbars have been RESET following RAT release, when the indicators show a horizontal line superimposed on cross-hatch indication, then electrical starting of the AAPP is selected.
2. Switch ON the master switch.
3. Set oxygen and relight switch to ON (if above 15,000 ft).
4. Confirm that the oxygen light illuminates.
5. Switch ON the LP cock.
6. Press the START button.
7. Check that the JPT, oil pressure, voltage and frequency are within limits.

An electrical start will also be achieved when the non-essential loads have been shed, by selecting the oxygen and relight switch ON, switching the master switch and LP cock ON and pressing the START button.

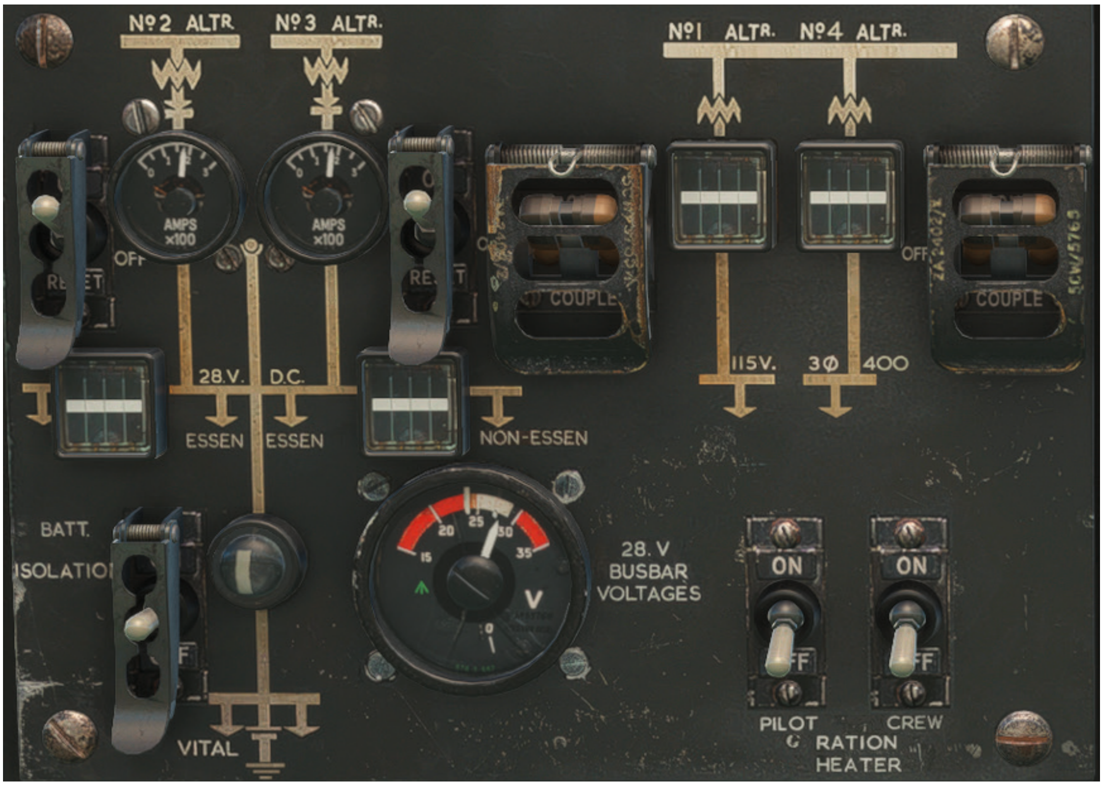
Shutdown:

1. Switch OFF the master switch.
2. Monitor the JPT, oil pressure, voltage and frequency.

Secondary power supplies

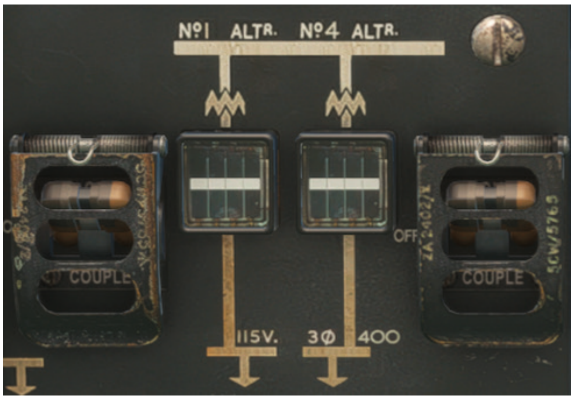
The secondary power supplies required to operate the aircraft equipment are provided by transformer-rectifier units (TRUs), transformers and frequency changers, all fed from the primary 200-volt AC busbars.

The controls and indicators for the main secondary supplies are grouped on the secondary supplies panel.



Transformers

Four transformers supply 115-volt, 3-phase, 400 Hz power: two main (each 3 kVA), one NBS (1 kVA) and a Green Satin (1 kVA).



Each main transformer normally supplies its own services but if one transformer fails, its loads are automatically transferred to the other transformer. Two ON/OFF/COUPLE switches on the secondary supplies panel control the transformers, and indications are provided by two three-position magnetic indicators adjacent to the switches.

When the transformers are ON, the indicators show line continuity. If one transformer fails and automatic coupling takes place, or if COUPLE is selected, its indicator shows discontinuity. When OFF is selected, the loads have no supply and the indicator shows cross-hatch.

28-volt DC

Four interconnected busbars are used to distribute the 28-volt power from two TRUs whose outputs are paralleled, either one being capable of supplying the total 28-volt system load.

The 28-volt loads are supplied from battery, vital, essential and non-essential busbars. The battery busbar is connected directly to the battery. The vital busbar is connected to both the battery and essential busbars. The essential busbar obtains its supply from either the battery, via the battery isolation contactor, the GPU or the TRUs. The non-essential busbars are fed via the port and starboard load shedding contactors from the essential busbars.

A 24-volt, 40 amp-hour battery is connected to the battery busbar and supplies the vital busbar at all times. When the battery switch is set to ON, the battery busbar is connected to the essential busbar for general use and for battery charging.

The controls for the 28-volt system are on the secondary supplies panel.

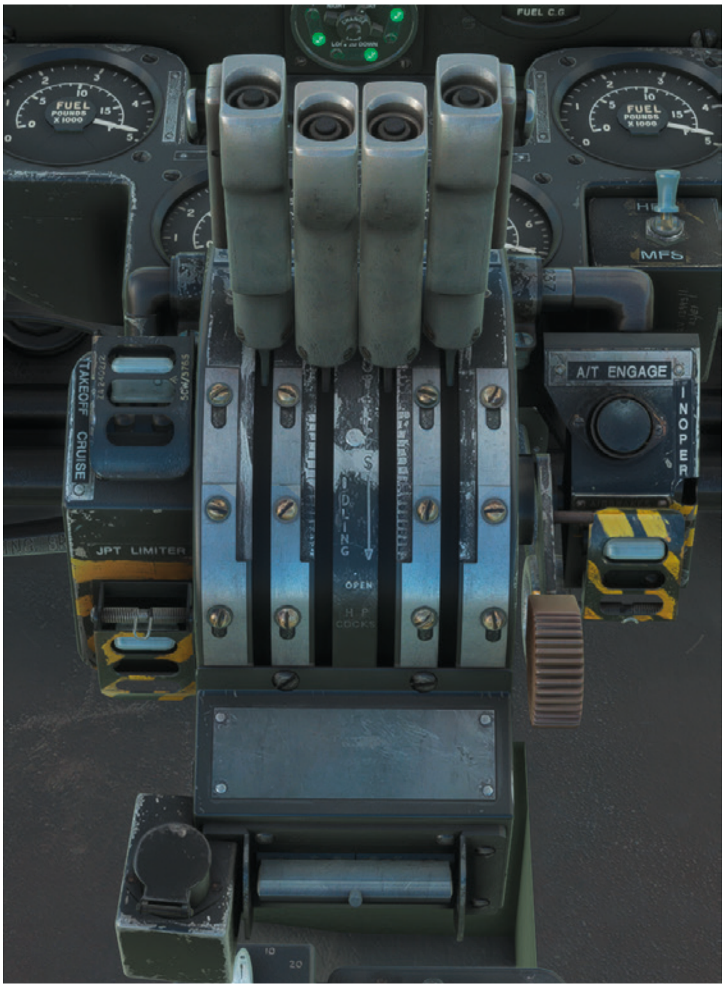
These consist of two guarded ON/OFF/RESET switches for the TRUs and a guarded ON/OFF switch, spring-loaded to the centre position, for the battery. Ammeters show the input to the TRUs. A magneto indicator shows the continuity of input between the battery and essential busbars. Three-position indicators between the essential and non-essential busbars normally show continuity between these busbars, show discontinuity when automatic load shedding (either by release of RAT or operation of the TEST/RESET switch) has taken place and show override (continuity on background of cross-hatch) when RESET is selected after RAT release. The non-essential supplies TRIP/RESET switch sheds and restores the non-essential loads independently of RAT operation.

External power supply

A 28-volt ground supply can be plugged into the port wing. This supply feeds all normal 28-volt services and, if the battery switch is on, charges the battery.

The external power supply can be enabled by clicking the GND POWER option on the Aircraft page of the EFB.

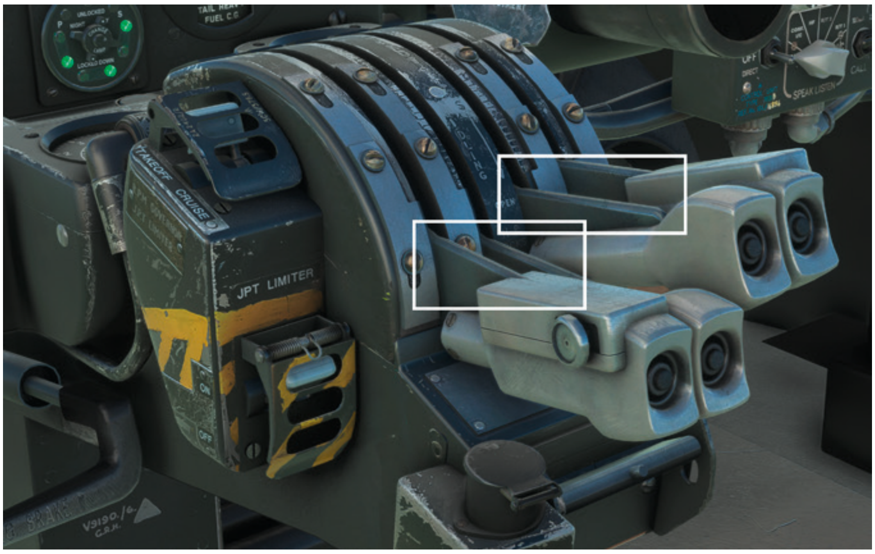
Engines



The aircraft simulated is powered by Olympus Mk. 301 engines. Engine control is provided by a combined throttle and HP cock. Limitations on engine output are controlled by the position of a TAKEOFF/CRUISE switch. A jet pipe temperature limiter is installed which controls the engine speed to prevent the jet pipe temperature limit being exceeded.

Throttle and HP cock controls

The four throttle levers, which also control the HP cocks, are forward of the retractable centre console in a quadrant marked OPEN/IDLING. The quadrant is gated at the IDLING position and the part of the quadrant below this, which controls the HP cock position, is marked OPEN / HP COCKS / SHUT and has a further gate at the SHUT position.



Left-click on the base of the respective throttle lever to move it forward from the HP cock's SHUT gate. With the throttle levers at the IDLING gate, left-clicking on the base of the respective throttle lever will move it aft to SHUT.

Although the aircraft is fitted with auto-throttle controls, these were inoperative on the Vulcan.

RPM governor

Each engine RPM governor has a double datum selector, allowing it to control RPM to take-off or cruise limits with the throttle at OPEN. The four selectors are controlled by a single TAKEOFF/CRUISE switch on the left side of the throttle levers. In addition to selecting the required RPM datum, the switch also selects the corresponding temperature datum for each engine JPT limiter.

JPT limiter

The JPT limiter works to prevent the jet pipe temperature limit being exceeded. It is controlled by the ON/OFF switch located aft of the TAKEOFF/CRUISE switch. With the switch on, jet pipe temperatures are controlled automatically. With the switch off, the limiter is overridden and the JPTs must be controlled by throttle movement.

Engine starting system

Each engine has its own starter motor. Air can be supplied from a ground air starter unit, feeding through a connection on the underside of the starboard wing, or from the rapid start system. The ground air supply feeds into the main lines of the engine air system and then to the starter motors through electrically actuated valves. Compressed air from a running engine can be used to start the others, singly or simultaneously, provided that the appropriate engine air switches on the starboard console are set to OPEN.

The rapid starting system is arranged so that the powered flying controls (PFCs) and artificial feel are switched on automatically when the simultaneous rapid start button is pressed. Because of the peak loads involved, electrical power during starting must be supplied by a ground power unit and not from the AAPP.

A gyro hold-off system is fitted which de-energises the MFS, JPT limiters, contents gauges, auto-stabilisers and artificial horizons until the engine start master switch is selected ON.

Controls

The starting control panel on the left console features the following controls:

- Four push-buttons for individual engine starting, each containing a light
- GYRO HOLD OFF push-button
- RAPID START push-button for starting all engines simultaneously
- NORMAL/RAPID lock-toggle selector switch for selecting Palouste or high-pressure air
- Ignition ON/OFF switch
- AIR CROSS FEED three-position magnetic indicator
- ON/OFF master switch (MSW)

An air cross-feed indicator shows OPEN whenever the master start switch is ON. When the air selector is set to NORMAL, engines can only be started by the individual push-buttons, using an external air supply or cross-feed. When the air selector is set to RAPID and the master switch is ON, all engines can be started simultaneously, by using the RAPID START push-button, or separately by using the individual buttons. With the air selector switch set to RAPID and the master switch OFF, the gyro hold-off system is effective when the hold-off button is pressed.

A relight button on each throttle lever provides a means of relighting the engines in flight. When one of the buttons is pressed, 28-volt vital busbar power energises the igniter plugs regardless of throttle position or switch selections on the engine start panel.

Operation – normal

With the IGNITION switch ON, MASTER switch ON and air selector switch set to NORMAL, pressing the starter button energises three circuits:

- Solenoid to open position on starter air control valve
- Engine igniter plugs
- Palouste air bleed valve

The increase in Palouste air opens the air control valve and a pressure switch illuminates the START button. The air rotates the starter turbine which drives the HP compressor. Fuel from the HP pump is directed to the burners, where the igniters initiate combustion. The engine accelerates and, once above self-sustaining speed, de-energises the engine igniters. The starter button light extinguishes.

Operation – rapid

With the IGNITION switch ON, MASTER switch ON and air selector switch set to RAPID, pressing the RAPID start button will start all four engines or pressing an individual starter button will start the corresponding engine.

The rapid start facility uses a mixture of bottled air and fuel from the booster pumps. When this mixture is ignited, the resulting hot gases turn the starter turbine. A pressure switch operates and makes the starter light come on. The engine accelerates and, once above self-sustaining speed, de-energises the engine igniters. The starter button light extinguishes.

Engine instruments

The following engine instruments are grouped together on the centre instrument panel:

- Four JPT gauges
- Four fuel pressure magnetic indicators which show white when there is sufficient pressure
- Four RPM indicators
- Four oil pressure gauges
- Engine control magnetic indicator (inoperative)

Fire protection system

There are four guarded fire extinguisher push-buttons, one for each engine, on the coaming above the centre instrument panel. Each button incorporates a red warning light which illuminates to indicate a fire. Pressing the button fires the extinguisher into the corresponding engine.

Similar controls are available on the co-pilot's instrument panel for the wings and fuselage, and a red warning light illuminates to indicate a bomb bay fire.

Flying controls

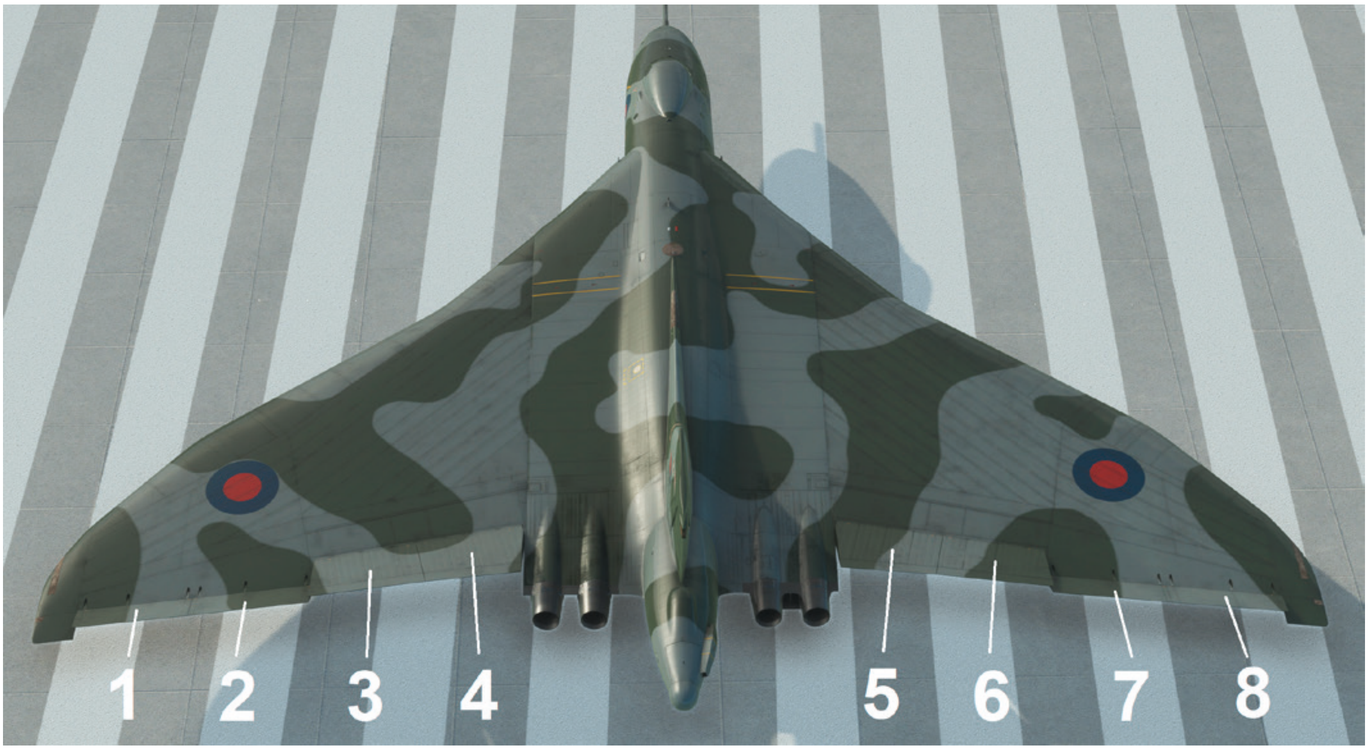
Powered flying controls (PFCs)

The flying controls in the cockpit are conventional in operation. Dual interconnected control columns and rudder pedals are provided, operating powered controls through a series of linkages.

The controls for the powered flying controls, artificial feel, auto-stabilisers and Mach trimmer are grouped together on the left console. The elevator and aileron trim and feel relief switches are duplicated on the two control columns. Those for the rudder are on the fuel contents panel. The emergency trim control is on the forward end of the retractable console.

Elevons

Control of the aircraft in the pitch and roll axis is achieved by eight elevons hinged into the wing trailing edge, four on each side. Each group of four is divided into two outboard and two inboard elevons. They are numbered 1 to 8 from port to starboard.



Each surface is operated by a separate electro-hydraulically powered flying control unit (PFCU).

If the control column is moved fore or aft, all eight elevons move down or up. If it is moved to the left, the port elevons move up while the starboard ones move down. If it is moved rearwards and to the right, all eight elevons move up but the starboard elevons move up to a greater degree than the port elevons. Full elevator and aileron travel cannot be obtained at the same time.

Rudder

The single rudder is controlled by two powered flying control units, one main and one auxiliary. Normal control is by the main unit with the auxiliary unit idling. Change-over occurs automatically if the main unit fails.

Powered flying controls (PFCs)

Each PFC unit consists of an electrically driven hydraulic pump, a servo-valve and a hydraulic jack to move the control surface. Movement of the cockpit control operates the assembly to supply fluid to the appropriate side of the jack, thus moving the control surface. When the control surface position coincides with the new position of the cockpit control, jack movement ceases and the control surface remains in the selected position until further control movements are made.

Incorporated in the assembly is a surface lock valve. As long as servo pressure is available, the valve is held open to allow fluid to pass to either side of the jack. If this pressure is not available, the valve closes under a spring load and no further fluid can pass to or from either side of the jack. This triggers the illumination of a warning light on the instrument panel. Control surface lock valves form a ground lock for the aircraft surfaces.

A 200-volt, 400 Hz AC supply is required to operate the PFC motors. This is supplied from the main busbars:

Elevons:

- No.1 and No.8 – No.1 busbar
- No.3 and No.6 – No.2 busbar
- No.4 and No.5 – No.3 busbar
- No.2 and No.7 – No.4 busbar

Rudder:

- Main – No.3 busbar
- Auxiliary – No.2 busbar

Artificial feel units

As the flying control system is irreversible, aerodynamic loads are not transmitted to the pilots' controls. To compensate for this lack of feel, artificial feel units are provided in the elevator, aileron and rudder control systems.

Elevator and rudder feel can be reduced to a minimum by use of feel relief switches, which also allow a full range of control movement.

If any part of the artificial system malfunctions, or in an emergency, the artificial feel may be relieved by using the guarded switch on the control column which relieves both the aileron and elevator systems.

The system in which relief is not required may be restarted by pressing the A start button for aileron feel or the E start button for elevator feel. Feel relief on the rudder is achieved by pressing the button on the fuel contents panel. To retain normal feel, the R start button should be pressed.

To prevent possible feel unit runaway while at low level at speeds greater than 250 knots, a locking facility is provided for all three channels and is controlled by a single switch. No further movement of normal or relief actuators can take place until NORMAL has been selected, although failure warning is given if the speed is altered by 30 knots from the speed at which LOCK was selected.

The actuators for the artificial feel are operated by 28-volt DC.

Trimmers

Control forces felt by the pilot in flight are produced by the compression or extension of the feel mechanism in response to control movement or change of airspeed. Trim adjustment is made by varying the length of the control run between the pilots' controls and the feel unit. This is done by an electrically operated actuator, which removes the load by resetting the feel actuator.

Electrical supplies for the system are 28-volt DC.

Auto-stabilisers and Mach trimmer

Pitch and yaw dampers (auto-stabilisers) are installed in the elevon and rudder circuits to improve the natural damping of aircraft oscillations. In addition, a Mach trimmer is installed to counteract the nose-down trim change at high Mach numbers.

The yaw damper system is duplicated, with the circuit in use being selected by the pilot. The actuators are in the rudder control circuit between the feel unit and the PFC. The system is airspeed-monitored – rudder displacement is constant up to 200 knots and then decreases as the airspeed increases.

Pitch dampers are provided to improve longitudinal stability at high altitudes and high Mach numbers (above M0.9). There are four channels in the system, each one feeding to one of the inboard elevon PFCs. The system is height-monitored and is inoperative below 20,000 ft. Above this altitude the amplitude of control movement increases with increase of altitude.

The Mach trimmer system is duplicated and operates on the elevator control run, thus controlling all eight elevons. The system is brought into operation by a height switch at 20,000 ft. The system applies up-elevon as the Mach number increases above M0.87. The amount of up-elevon applied is always the sum of the movement of two actuators. Full extension of both actuators represents a total up-elevon movement of 12 degrees (6 degrees for each) but this is only achieved at a Mach number of approximately M0.96.

The gyros and amplifiers in the systems are operated by 115-volt, 3-phase, 400 Hz AC, while the servos, motors and relays are operated by 28-volt DC.

Controls and indicators

The controls for the PFCs, auto-stabilisers, Mach trimmer and artificial feel are grouped together on a panel on the port console. Controls for trim and feel relief are on each pilot's control column and on the fuel contents panel. The PFC motor controls, pitch damper and Mach trimmer control buttons incorporate warning lights.

At the top of the centre instrument panel is a bank of warning lights and magnetic indicators. The three left-hand magnetic indicators are for the PFC units, the artificial feel and the auto-stabilisers respectively. There is a control surfaces position indicator below the warning lights and indicators.

The 10 push (off) spring-loaded stop buttons for the individual PFC units are arranged along the inboard edge of the panel, those for the elevons being grouped in pairs to indicate outboard and inboard pairs of elevons. The inboard button of the rudder pair controls the main unit. Each button incorporates a warning light which illuminates if the unit malfunctions.

Three PFC START push-buttons, which also engage the feel systems, are at the rear of the panel and are marked A, R and E. A signifies the outboard elevons and aileron feel, R the rudder and rudder feel, and E the inboard elevons and elevator feel.

The three push (off) / pull (on) buttons for the artificial feel warning systems are at the forward end of the panel and are marked FEEL A, R and E. In this case the letters stand for aileron, rudder and elevator feel. Each button incorporates a warning light. When the button is pushed in, the main warning on the pilots' centre instrument panel is cancelled.

At the outboard side of the panel are the controls for the auto-stabilisers and Mach trimmer. These consist of:

- YAW DAMPERS NO.1/OFF/NO.2 switch
- RESET COMPARATOR spring-loaded push-button for the pitch dampers and Mach trim
- Four PITCH DAMPERS push (off) / pull (on) buttons, each incorporating a warning light
- Two AUTO-TRIM ON/OFF spring-loaded push-buttons, each incorporating an extension indicator light
- AUTO TRIM ON/OFF push/pull button, incorporating a warning light

Each pilot's control column carries the following feel and trim switches:

- Four-way aileron and elevator trim button
- Guarded artificial feel relief switch for the aileron and elevator feel

The throttle quadrant and retractable console have the following controls:

- Twin rudder trim switches on the fuel contents panel, spring-loaded to the centre (off) position. They are marked RUDDER TRIM PORT/STBD.
- RUDDER ART. FEEL RELIEF push-button on the fuel contents panel
- Emergency trim switch for all the trim circuits on the retractable console

The centre instrument panel has the following indicators:

- At the top of the centre instrument panel is a bank of warning indicators. The three left-hand magnetic indicators are for the PFC units, the artificial feel and auto-stabilisers respectively.
- The auto-stabiliser indicator shows white if any channel is switched off or fails.
- The artificial feel indicator is a three-position indicator which shows black, white or ILS. It shows black during normal flight conditions, ILS during approach conditions (with TRACK and LOC & GP selected) and white if any of the relays fail or if the aileron or rudder channels disengage.
- The PFC indicators only show white if any PFC stop button is pressed, or when servo pressure falls below 35-50 PSI and if a 28-volt supply is available.
- The amber MAIN WARNING lights at either end of the group come on if a fault develops in any of the systems (except the yaw damper). This warning is cancelled by pushing in the button of the channel concerned. The appropriate magnetic indicator shows white as a reminder that a channel is unserviceable. The main warning lights are then available for any subsequent failure.
- Below this group is the control surfaces position indicator, representing a view of the aircraft from the rear. There is a separate indicator for each of the control surfaces, with datum lines to show the surface position relative to the take-off position.

Operation

Starting the PFCs

With electrical power available and the PFC and artificial feel buttons out, the PFC motors and the artificial feel are started by pressing the START push-buttons. Check that the two left-hand magnetic indicators show black and that the lights in the buttons are out. After flight and before turning off the secondary power supplies, push in all the control buttons. Those for the PFCs are spring-loaded to the out position.

Artificial feel lock

When flying at speeds above 250 knots at low altitude, set the feel lock switch to LOCK when the desired speed has been reached and check that the light illuminates.

If the speed is changed by more than approximately 30 knots from the locking speed, the main warning lights and the lights in the feel indicator buttons illuminate and the magnetic indicator goes white. To prevent the main warnings coming on, push in the feel indicator buttons. The lights in the indicator buttons come on and the magnetic indicator shows white.

Before the feel is unlocked, reduce speed to below 250 knots, trim out the control forces and then raise the feel indicator buttons. The main warning lights will illuminate. Unlock the feel and ensure that all failure warnings disappear.

Trim controls

Aileron and elevator trimming are achieved by using the appropriate control assignments. This will cause the trim button on the control column to move.

Rudder trimming is achieved by using the appropriate control assignments or by moving the rudder switches on the throttle quadrant in the required direction.

The emergency trimmer on the retractable console can also be used. This is moved fore and aft for longitudinal trim, sideways for lateral trim and rotated for rudder trim.

Yaw dampers

To switch on the yaw dampers, the selector switch is put to No.1 or No.2 as required. The yaw damping will always be in operation and at all heights when either motor is selected. The magnetic indicator shows white when the switch is off. A power supply failure to the selected yaw damper does not necessarily give a white indication. The switch must be put to the OFF (centre) position after flight.

Pitch dampers

The pitch dampers are energised by pulling out the selector buttons on the left console. The buttons may be pulled out at any stage of the flight, but the dampers are inoperative until the height switch permits their operation at 20,000 ft. The buttons must be pushed in after flight.

Mach trimmer

Both Mach trim servos are energised by pulling out the single ON/OFF button on the left console. The system does not operate at heights below 20,000 ft and only starts applying nose-up trim at speeds above M0.88. The blue lights in the reset buttons are illuminated whenever the servos are extended.

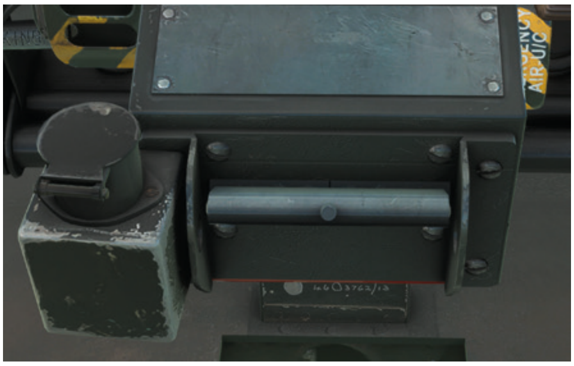
Airbrakes

The slat-type airbrakes in the mainplane, located above and below the engine air intakes, are electrically operated by two motors using 200-volt, 3-phase AC. The port motor is supplied by No.2 busbar and the starboard motor by No.3 busbar. The supplies to the airbrakes are disconnected if load shedding occurs.

The airbrakes have three extended positions:

- Medium drag – 35°
- High drag (undercarriage up) – 55°
- High drag (undercarriage down) – 80°

The transition from 55° to 80° is automatic when the undercarriage is lowered.



The airbrakes are controlled by the default MSFS spoiler control assignments or a ganged switch on the rear face of the throttle quadrant. The switch has three positions: IN, MEDIUM DRAG and HIGH DRAG.

The airbrakes are operated by two electric motors. If one motors fails, the other can be brought into operation by selecting the NORMAL/EMERGENCY switch on the throttle quadrant to EMERGENCY.

The three-position magnetic indicator for the airbrakes is at the top of the centre instrument panel. It shows white when no power is available or when selected out, and black when power is on and the airbrakes are in.

Brake parachute

A brake parachute is installed in the tail cone, aft of the rudder, to provide additional braking during the landing run.

Parachute operation is electrically controlled by a JETTISON/STRM switch on the centre instrument panel. Move the switch down to select STRM to deploy the parachute and move the switch up to select JETTISON to jettison the parachute. The switch can also be operated with the TOGGLE ARM SPOILERS control assignment. A single activation of this control assignment will stream the parachute and a second activation will jettison the parachute. An AUTO CHUTE JETT option on the EFB Aircraft page will automatically jettison the braking parachute at 60 knots if enabled.

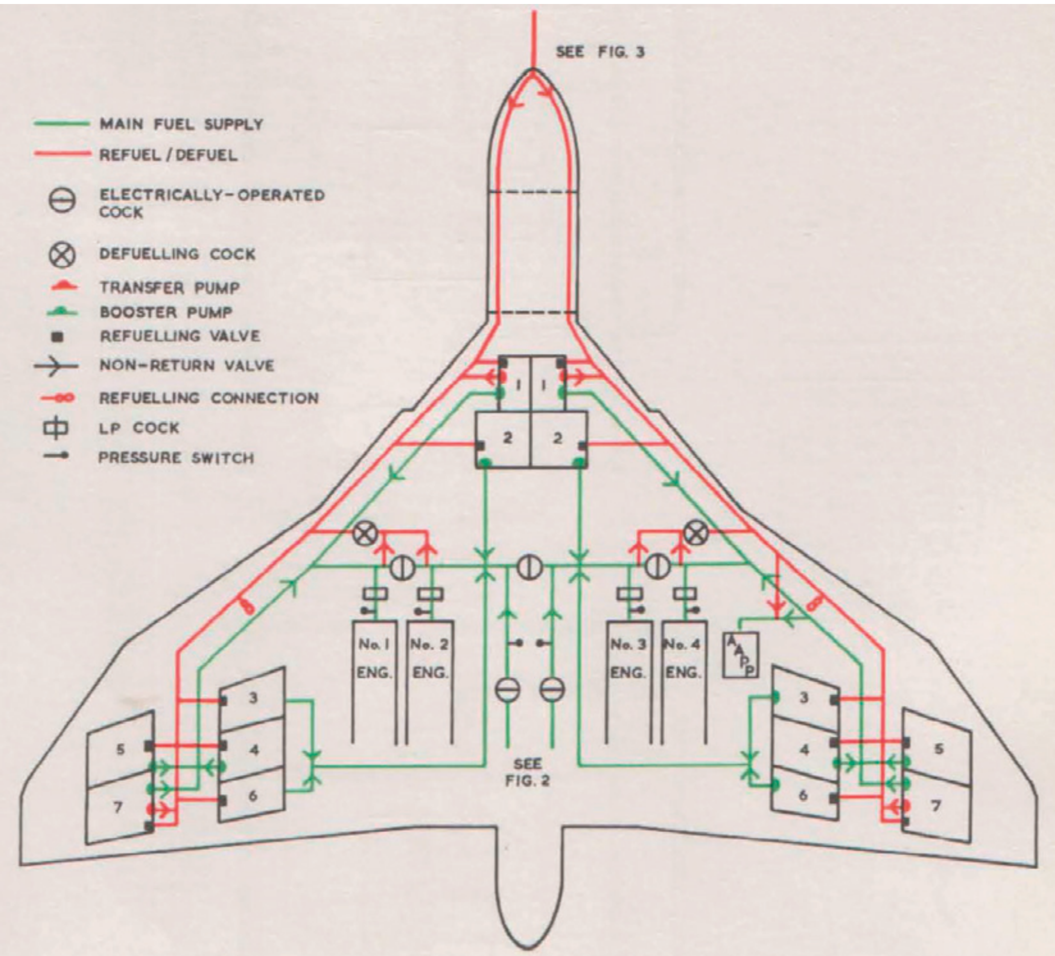
Once jettisoned, the braking parachute can be refitted either by restarting the flight or by clicking the RESET BRAKE CHUTE option on the EFB Aircraft page.

The brake parachute operation uses 28-volt DC.

Note: *We are aware of an animation issue that is preventing the braking parachute from opening completely. This issue is due to limitations within MSFS and we are awaiting a response from Asobo/Microsoft on potential fixes. If we are able to offer a fix we will be sure to implement it in a free update to the Vulcan. We also plan on revisiting the parachute animation with the additional body deformation physics that will feature in MSFS 2024.*

Fuel system

Fuel is carried in fourteen pressurised tanks: five in each wing and four in the fuselage, above and to the rear of the nose-wheel bay. The tanks are divided into four groups, each group normally feeding its own engine. A cross-feed system enables the various groups to be interconnected. Automatic fuel proportioning is normally used to control the fuel CG position.



Provision is made for carrying either saddle-shaped or cylindrical fuel tanks in the bomb bay. Fuel from these tanks passes into the main system through two delivery lines to each side of a centre cross-feed cock.

An air-to-air refuelling system is fitted. The nose probe is in the nose and pipes from it join the normal refuelling lines.

The majority of the controls and indicators for the fuel system are grouped in the form of a mimic diagram on the retractable console.

The air-to-air refuelling controls are on the starboard console.

Fuel tanks

The tanks on each side of the aircraft are numbered from 1 to 7. No.1 and No.2 are fuselage tanks and the remainder are wing tanks. The tank numbers correspond to the CG position of each tank, with No.1 having the furthest forward CG and No.7 the furthest aft.

No.1, 4, 5 and 7 tanks comprise the outboard tank group in each wing (No.1 group port, No.4 group starboard). No.2, 3 and 6 tanks comprise the inner tank groups (No.2 group port, No.3 group starboard). Each group normally feeds its associated engine.

Two fuel tanks can be carried in the bomb bay: one at the forward end and one at the rear end.

The fuel tank for the airborne auxiliary power plant (AAPP), located in the starboard wing to the rear of the AAPP, has a capacity of 10 gallons. The tank is filled from the main fuel system via a line from the wing tanks of No.4 group whenever the No.4 group wing booster pumps are running.

Tank Group	Tank No.	AVTUR (8 lb/gal.)		AVTAG (7.7 lb/gal.)	
		Gallons	Pounds	Gallons	Pounds
1 and 4 (outboard, port and starboard)	1 4 5 7	2x 610 2x 630 2x 515 2x 565	2x 4,880 2x 5,040 2x 4,120 2x 4,520	2x 620 2x 640 2x 525 2x 575	2x 4,774 2x 4,928 2x 4,042.5 2x 4,427.5
	Total Each Group	2x 2,320	2x 18,560	2x 2,360	2x 18,172
	Total Both Groups	4,640	37,120	4,720	36,344
2 and 3 (inboard, port and starboard)	2 3 6	2x 935 2x 630 2x 745	2x 7,480 2x 5,040 2x 5,960	2x 945 2x 640 2x 755	2x 7,276.5 2x 4,928 2x 5,813.5
	Total Each Group	2x 2,310	2x 18,480	2x 2,340	2x 18,018
	Total Both Groups	4,620	36,960	4,680	36,036
	Total Fuel	**9,260**	**74,080**	**9,400**	**72,380**

Each tank group can be pressurised with air from its associated engine. Pressurisation of the main tanks is controlled by a switch on the air-to-air refuelling panel. Below the switch are four magnetic indicators, one for each tank group, which show black when the tanks are pressurised. A switch on the centre console is provided for bomb bay tank pressurisation but it is inoperative.

Controls and indicators

Retractable console

The fuel panel on the retractable console carries a mimic diagram of the system, including the bomb bay tanks.

Forward of the diagram are three CG control switches, two FWD/AFT transfer pump switches (one for each side of the system) and one PORT/STBD switch for use during air-to-air refuelling.

On each side of the diagram are two AUTO/MANUAL switches, one for each group. These switches control sequence timing.

In each tank on the diagram is an OFF/ON pump switch, which controls both the main and auxiliary pumps, and a CONT push-button for reading the contents.

The cross-feed cocks are represented in the diagram by three magnetic indicators, with OPEN/CLOSE cock switches to the rear of them.

Four push-buttons marked NO.X ENG are provided for flow meter selection.

The bomb bay system diagram has two BOMB BAY / MAIN switches, two ON/OFF pump switches for each tank and a pressurisation switch (inoperative).

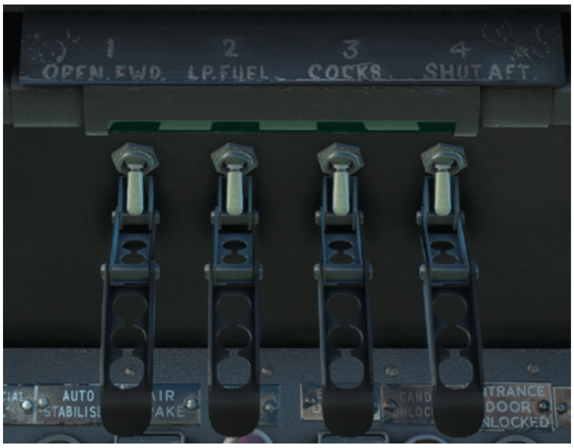
Starboard console

The air-to-air refuelling controls are grouped on a panel on the right console and consist of:

- Two probe lighting dimmer switches
- Nitrogen purge switch
- Main tanks pressurisation switch
- Four tank pressurisation magnetic indicators
- ON/OFF master switch
- Refuelling indicator
- Refuelling gallery pressure gauge

Fuel cocks

The four HP cocks are opened by the initial movement of the throttle levers forward from the fully closed position. Left-click on the base of the throttle levers to move them forward from the HP cocks SHUT gate. With the throttle levers at the IDLING gate, left-click on the base again to move them aft to SHUT.



The four LP cocks are electrically controlled by four guarded ON/OFF switches on the underside of the coaming above the centre instrument panel.

Cross-feed cocks and indicators

There are two wing cross-feed cocks, each connecting the tank groups on that side, and a centre cross-feed cock between No.2 and No.3 groups. The cocks are electrically operated.

Three three-position magnetic indicators show continuity with the diagram lines when the cocks are open, discontinuity when the cocks are shut, and cross-hatch when the cocks are at an intermediate position or when no power is available.

Fuel pumps

Each wing tank contains both a booster pump and an auxiliary pump. The fuselage tanks have a single booster pump.

Each saddle-type bomb bay tank has four booster pumps, with one pair supplying each feed from the tank. The pumps run in parallel and each pump switch controls one port and one starboard pump in its tank.

Each cylindrical tank has three booster pumps. The same controls are provided, with the right-hand pump switch for each tank controlling the forward pump and the left-hand switch controlling the other two pumps.

Transfer pumps in No.1 and No.7 tanks on each side allow fuel to be transferred in either direction between these tanks if it is necessary to adjust the fuel CG position. As both tanks are in the same group, transfer does not affect the group contents.

With a transfer pump switch at FW, the refuelling valve of No.1 tank opens and No.7 tank pump starts and transfers fuel to No.1 tank. Placing a switch to AFT opens the refuelling valve of No.7 tank and starts the No.1 tank pump.

Four magnetic indicators on the centre instrument panel, below the JPT gauges, show black when the fuel pressure to the engine is satisfactory, white when the pressure falls below 5 PSI and black when there is no power supply.

The two bomb bay fuel indicators show black when the fuel pressure is sufficient and the cocks are open. They show white if the fuel pressure falls below 10 PSI.

Sequence timers

Because of the configuration of the aircraft, the fuel tanks are located forward and aft of the aircraft's centre of gravity. It is therefore essential that fuel is used at approximately the same rate from all tanks in order to maintain the fuel CG position. An electrically operated sequence timer on each side of the aircraft ensures even fuel distribution by sequentially drawing fuel from each of the tanks to feed the engine.

With all booster pumps ON and the AUTO/MANUAL switches at AUTO, sequence timing is in operation. To interrupt the sequence timing in any group, put the appropriate switch to MANUAL. If you wish to use fuel from any particular tank in the group, switch OFF all booster pumps which are not required. The AUTO/MANUAL switches should be set to MANUAL after flight.

Fuel contents gauges

Four main tank contents gauges, one for each tank group, are on a panel forward of the throttle levers. Each gauge is calibrated with two concentric scales and they read in pounds x 1,000. Normally each gauge reads the contents of its appropriate group on the inner scale. An individual tank reading is obtained on the outer scale by pressing the push-button in the appropriate tank position on the mimic diagram. The gauges are powered by the 28-volt DC supply.

A contents gauge for the bomb bay tanks is on a panel attached to the Captain's ejector seat. A push-button is provided for individual tank selection.

Flow meters

Two flow meters are provided on the co-pilot's instrument panel to give the following indications:

- Fuel consumption by individual engine (lb/min)
- Total fuel consumption by all four engines (lb/min)
- Total amount of fuel used (lb)

Two indicators, one giving total flow/pounds used and the other giving instantaneous flow for individual engines, are on the co-pilot's instrument panel, together with a FUEL FLOW/RESET/NORMAL switch for resetting the total flow indicator.

Selection of an individual engine flow is obtained by pressing the appropriate engine push-button on the fuel system mimic diagram. The instrument continues to indicate the flow to that engine until another engine is selected.

CG indicator

A fuel CG position indicator on the centre instrument panel indicates the CG of the fuel system. Readings can be taken by pressing the CG CHECK button.

The instrument face has two arcs, one for each side of the fuel system. Each arc is divided into three sectors: a central green sector to indicate the safe range and red outer sectors marked NOSE HEAVY and TAIL HEAVY. The needles should be on or near the zero position.

Air-to-air refuelling controls

The air-to-air refuelling indicator consists of the outline of the aircraft with numbered lights in the position of each tank. The lights illuminate when the valves open and go out individually as the tanks fill.

The master switch must be set to ON before refuelling starts. This opens the refuelling valves, depressurises the tanks and isolates the fuel contents gauges, resulting in them reading zero. All lights in the indicator illuminate and extinguish again as the associated tank is filled.

After refuelling is complete, the master switch must be set to OFF and the nitrogen purge switch set to ON to force any fuel from the probe lines.

The aircraft CG can be controlled during air-to-air refuelling by three switches on the fuel control panel: the two switches which normally control the transfer pumps for fore and aft control, and the PORT/STARBOARD switch at the top of the panel, marked FR RECEIVER CG CONTROL, for lateral control.

When the refuelling master switch is ON, the transfer pump switches are disconnected from the transfer pumps. Setting them to FWD closes the refuelling valves in tanks 6 and 7, while setting them to AFT closes the refuelling valves in tanks 1 and 2. The refuelling valves remain open in all other tanks. If the lateral control switch is moved to PORT or STBD, the refuelling valves in the No.6 and No.7 tanks on the opposite side are closed.

Fuel system management

Before starting engines:

1. Set the AUTO/MANUAL switches to MANUAL.
2. Check fuel contents and booster pump and cross-feed operation.
3. Switch on one booster pump in each group and confirm that the magnetic indicator is black.
4. Confirm that the LP cocks are open.
5. After starting, switch on all booster pumps and put the AUTO/START switches to AUTO.

Before take-off:

1. Confirm all booster pumps are on.
2. Move all transfer switches to the centre position.
3. Confirm that the cross-feed cocks are closed.
4. Set the AUTO/MANUAL switches to AUTO.
5. Set tank pressurisation ON.

After shutdown:

1. Set all booster pumps to OFF.
2. Set AUTO/MANUAL switches to MANUAL.
3. Move all transfer switches to the centre position.
4. The LP cocks are normally left open.

In flight

With the AUTO/MANUAL switches at AUTO and all booster pumps ON, fuel balancing is maintained automatically, ensuring that the fuel CG remains approximately constant.

Make systematic checks of all tank contents at frequent intervals. The contents of corresponding tanks on opposite sides of the aircraft should be approximately the same.

When the contents of any tank in a group has fallen to 400 lb, set the AUTO/MANUAL switch for that group to MANUAL and switch off the booster pump for that tank when the fuel level falls to 150 lb.

Cross-feeding

If an engine fails or is shut down for a long period, or if the fuel feeds unevenly for any reason, cross-feeding is necessary to maintain a lateral fuel balance. The appropriate cross-feed cocks must be opened and the system can be left at AUTO. Switch off the booster pumps on the side containing less fuel until lateral balance has been restored.

Landing fuel

Although all the fuel indicated on the fuel contents gauges is usable, the recommended minimum fuel for final landing is 8,000 lb total.

Bomb bay fuel tanks

Use the fuel in the bomb bay tanks as soon as possible after take-off. Before selecting the bomb bay tanks, the main tank AUTO/MANUAL switches must be set to AUTO and all booster pumps must be ON.

When established in the climb:

1. Open the wing cross-feed cocks.
2. Set both pump switches ON for each tank in use.
3. Set both BOMB BAY / MAIN switches to BOMB BAY.
4. Check that the bomb bay magnetic indicators change to white when the pump switches are set to ON and then revert to black as the pressure builds up.
5. When the magnetic indicators show white, or the tank contents have fallen to 150 lb, set the BOMB BAY / MAIN switches to MAIN.
6. Switch OFF the booster pumps and close the wing cross-feed cocks.

General equipment

Entrance door

The aircraft is entered by the door on the underside of the fuselage, below the crew compartment, which is fitted with a folding ladder. The door is hinged at the forward end and opens downwards. To open and close the door, click the CREW DOOR button on the Aircraft page of the EFB.

A magnetic indicator on the centre instrument panel shows white when the door is unlocked.

Ejector seats

The cockpit is fitted with ejector seats for the Captain and co-pilot. The seats have adjustable armrests to improve visibility of the consoles.

The seat pins can be fitted or stowed by clicking on any one of the pins. They are automatically fitted or stowed when selecting either of the two panel states.

Windscreen wipers

Windscreen wipers are provided for each pilot's windscreen panel and for the centre windscreen. The wipers are electro-hydraulically operated. The wipers for the Captain's and centre windscreen share a common motor, while the co-pilot's has an independent system.

The wipers are controlled by two three-position OFF/FAST/SLOW switches, one for the Captain and centre windscreen and one for the co-pilot's wiper.

The wipers are operated by 28-volt DC.

Visors

Sun visors are provided for the windscreen and side panels. The side visors slide down and the front ones are hinged at the top.

Anti-flash screens are provided for the side windows. The screens for the side windows are sliding shutters.

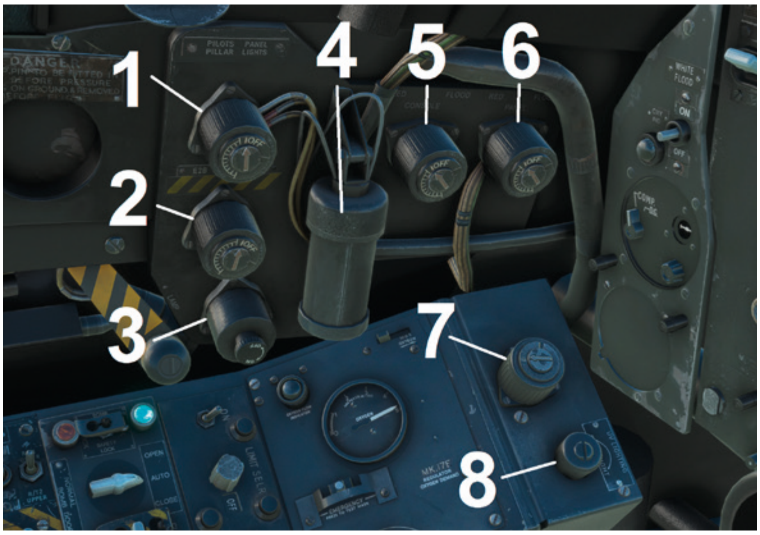
Lighting

Internal lighting

The interior lighting consists of the following main systems:

- **Cabin and general lighting** – for interior illumination
- **UV radiation** – for the pilots' instrument panels
- **Red floodlighting** – for the pilots' control consoles and instrument panels
- **Red fluorescent lighting** – for floodlights and crew stations
- **Red pillar lamp lighting** – for the pilots' instrument panel
- **White fluorescent lighting** – for white illumination of the pilots' consoles
- **High intensity anti-dazzle lighting** – for use in special circumstances

Controls for the interior lights can be found at various locations around the cockpit.



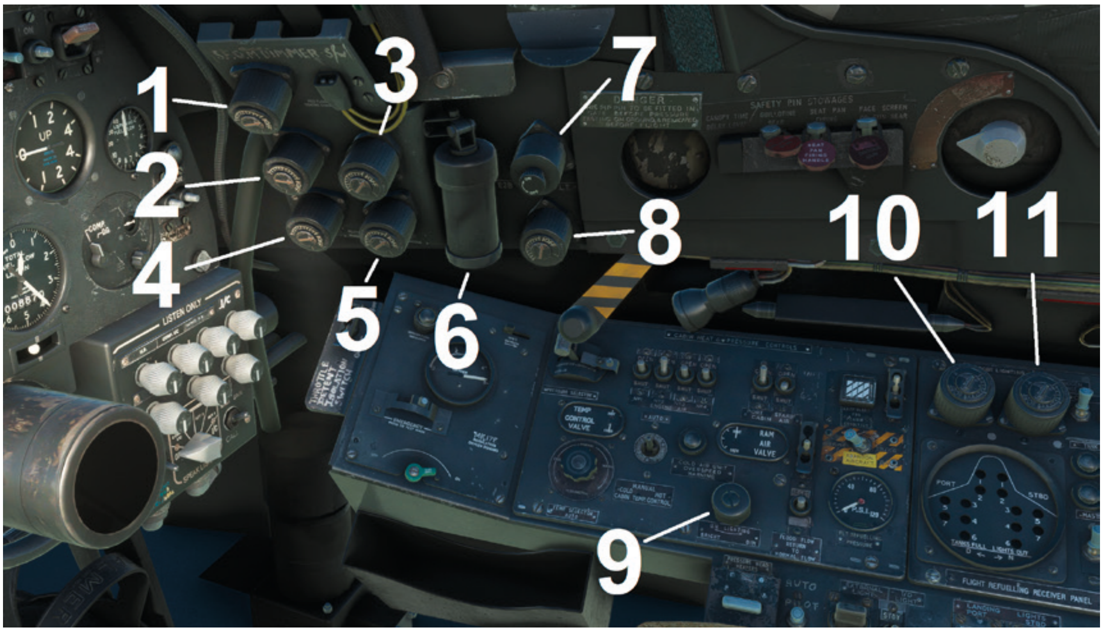
The left side console features the following internal lighting controls:

1. Red pilot panel pillar light dimmer switch
2. Red port e2b compass light dimmer switch
3. 1st pilot's knee pad lamp dimmer switch
4. 1st pilot's adjustable knee pad lamp
5. Red port console floodlighting dimmer switch
6. Red port main instrument panel floodlighting dimmer switch
7. UV oxygen panel lighting dimmer switch
8. UV port main instrument panel and throttle box lighting dimmer switch

The main instrument panel features the following internal lighting controls:

1. White port console floodlighting switch
2. High intensity anti-dazzle lighting switch (BRT/OFF/DIM)
3. White starboard console floodlighting switch

The right side console features the following internal lighting controls:



1. Red S.F.O.M. gunsight lighting dimmer switch
2. Red port centre console lighting dimmer switch
3. Red starboard centre console lighting dimmer switch
4. Red starboard main instrument panel floodlighting dimmer switch
5. Red starboard console floodlighting dimmer switch
6. Co-pilot's adjustable knee pad lamp
7. Co-pilot's knee pad lamp dimmer switch
8. Red starboard e2b compass light dimmer switch
9. UV starboard main instrument panel and centre coaming lighting dimmer switch
10. Port fuel probe lamp dimmer switch
11. Starboard fuel probe lamp dimmer switch

Some artistic licence has been used for the simulation of the UV lighting. In the real aircraft these UV lights would not be visible to the eye and would only illuminate the instrument markings. In our simulation of the Vulcan the UV lights will illuminate green.

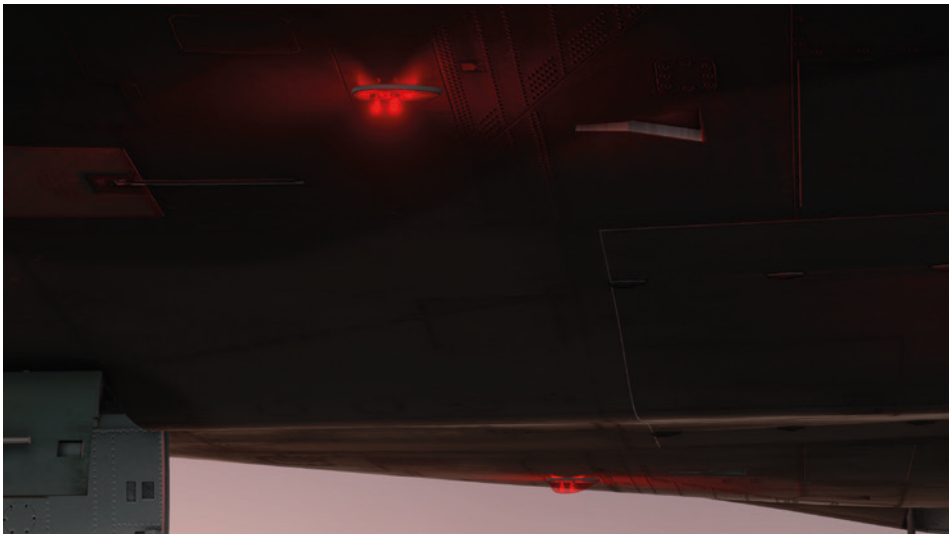
The internal lighting uses 115-volt, 3-phase AC from the main transformers.

External lighting

The external lighting can be controlled via the switches on the external lighting control panel on the starboard console:

- External light master switch
- Downward identification lamp
- Landing light port
- Landing light starboard
- Navigation lights

Before any of the external lighting can be used, the EXTERNAL LIGHT master switch must be set ON.



Steady navigation lights are provided, with rotating beacon lights on the top and bottom of the fuselage. The control is marked NAV LIGHTS – STDY/FLASH. When STDY is selected, the navigation lights are steady and the rotating beacon lights are off. When FLASH is selected, the navigation lights are steady and the rotating beacon lights operate.

A downward identification light is controlled by a STEADY/OFF/MORSE switch on the inboard side of the right console. The switch is spring-loaded from MORSE to OFF.

There is a combined landing/taxi lamp under each wing. The lamp extends further for the taxi position than for landing. The lamps are individually controlled by two three-position RETRACT/LANDING/TAXI switches on the inboard side of the right console.

The lamps incorporate a mechanism which automatically retracts them if the airspeed exceeds 180 knots. Once the lamps have retracted, the control switches must be reselected to RETRACT and then to LANDING before the lamps will re-extend.

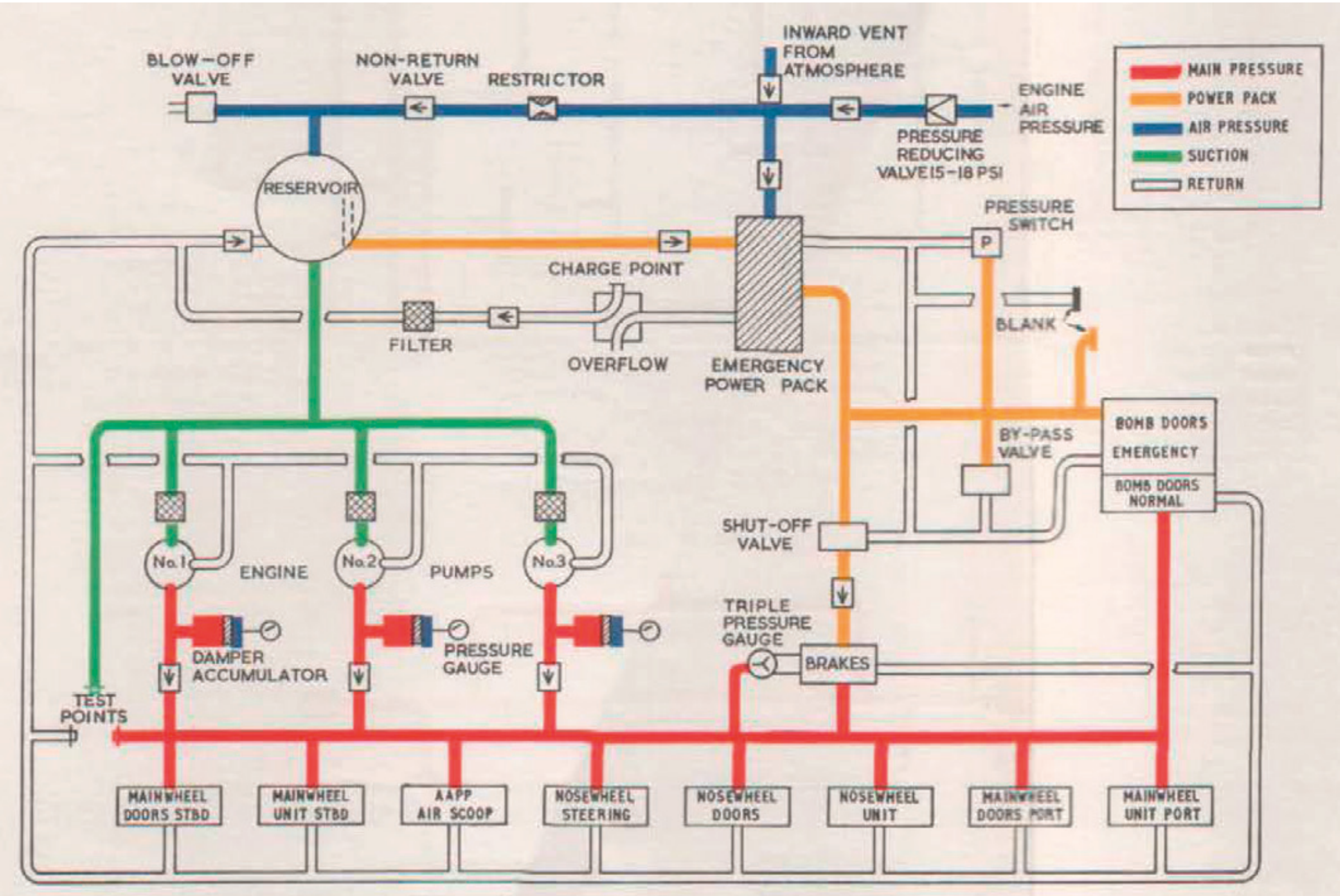
Hydraulic system

The main hydraulic system provides pressure for operating:

- Undercarriage raising/lowering
- Nose-wheel centring/steering
- Bomb doors opening/closing
- AAPP air scoop

An electrically operated hydraulic power pack unit (EHPP) is installed for operation on the ground of the bomb doors and wheel brakes. It may also be used for in-flight operation.

An emergency air system is provided for lowering the undercarriage, and separate self-contained electro-hydraulic systems are provided for the PFCs and the windscreen wipers.



Main system supplies

Engine-driven pumps

Three engine-driven pumps, one on each of No.1, 2 and 3 engines, draw fluid from a reservoir. From the pumps, fluid is delivered to the main gallery at a pressure of 3,600-4,000 PSI. In addition to supplying the various services, this pressure is used to charge the wheel brake accumulators.

Hydraulic pressure gauge

A triple pressure gauge is on the centre instrument panel. The left-hand arc shows the pressure in the main gallery, while the two right-hand arcs show the pressure in the two brake accumulators.

Operation

When the engines are running, check that the main and accumulator pressures are between 3,600-4,250 PSI.

The main pressure drops when a hydraulic service is operated. Check that it does not exceed 4,400 PSI after the operation and that it stabilises back in the normal range.

To check that all pumps are working, use the normal selector to open the bomb doors and confirm that they don't take longer than seven seconds to reach the open position.

Hydraulic power pack

An electrically operated hydraulic power pack unit (EHPP) provides emergency pressure for operating the bomb doors and for recharging the brake accumulators.

The unit consists of a 3-phase electric motor driving a pump in a reservoir. This is pressurised by engine air. The power pack is filled from the main reservoir. The pump delivers fluid at a pressure of 4,000 PSI and uses 200-volt AC from No.2 busbar.

The hydraulic power pack is energised to supply the bomb doors when the bomb doors emergency switch is set to the OPEN or CLOSED position.

Undercarriage system

The undercarriage main-wheel units are four-wheel, eight-tyre bogies.

The nose-wheel unit is a steerable twin-tyre.

Hydraulic pressure operates the undercarriage doors, extension mechanism, bogie trimmers and down-locks through electrically controlled selector valves.

Normal control and operation

Undercarriage raising and lowering is controlled by an UP and a DOWN button on the centre instrument panel. When the weight of the aircraft is on its wheels, a safety device prevents the undercarriage from being raised.

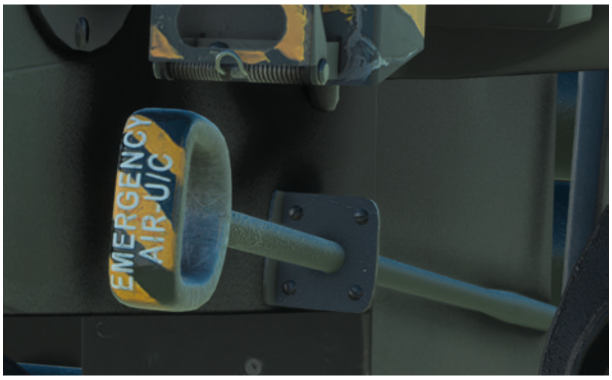
Undercarriage position indicator

The undercarriage position indicator is on the centre instrument panel and indicates as follows:

- All wheels up and doors locked closed – no lights
- Wheels unlocked – three red lights
- Wheels locked down – three green lights

A white flag indicator is also provided on the airspeed indicator which will flash if the airspeed drops below 160 knots and the gear is not locked down.

Undercarriage emergency air system

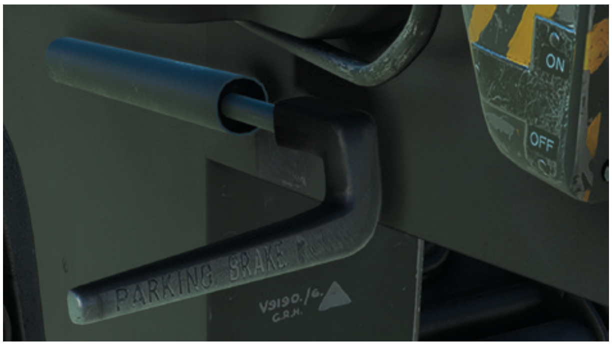


The emergency air supply for the main wheels and nose-wheels is contained in two separate bottles. The two controlling valves are mechanically linked and are operated by a handle on the right of the throttle quadrant. When the handle is pulled to its full extent, the undercarriage lowers regardless of the position of the normal selector.

Wheel brakes

The brake units are hydraulically operated. Two accumulators provide a reserve of pressure for brake operation and can be recharged by the hydraulic power pack.

The pressure at the brakes is shown on the triple pressure gauge on the centre instrument panel.



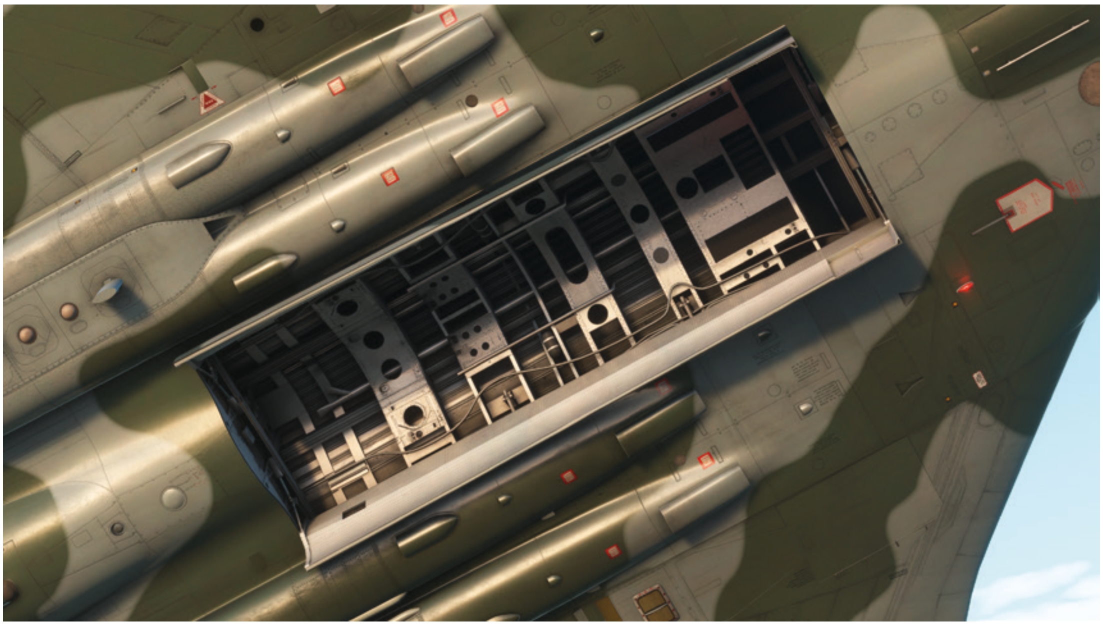
A parking brake is provided, which operates through a cable to open simultaneously all the hydraulic valves in the brakes control valve. The parking brake is applied by turning and pulling the lever on the left of the throttle quadrant.

If it is necessary to recharge the accumulators in flight or on the ground when the engines are not running, this can be done by the hydraulic power pack.

The brake accumulators can be charged from the power pack by operation of the START/STOP switch on the centre instrument panel. The switch is spring-loaded to the central position. With the switch moved to START and released, the power pack charges the accumulators in approximately six seconds and switches off automatically when the line pressure reaches 4,000 PSI, unless it has already been stopped by selecting STOP. While the brake accumulators are being charged, both normal and emergency bomb door selection is inhibited by an automatic shut-off valve. To ensure that the hold-off device is reset, select STOP after each operation.

Bomb doors

The bomb doors are hydraulically operated. For normal operations, supplies from the main system are fed through dual selector valves to door jacks. If the normal supply fails, the doors can be operated through a separate system from the hydraulic power pack.



The Captain has two switches on the left console, labelled BOMB DOOR CONTROL NORMAL and EMERGENCY. The NORMAL switch is a rotary-type selector with three positions: OPEN/AUTO/CLOSE. When OPEN or CLOSE is selected, the bomb doors operate at the time of selection. The NORMAL switch can also be operated using the TOGGLE TAIL HOOK HANDLE control assignment.

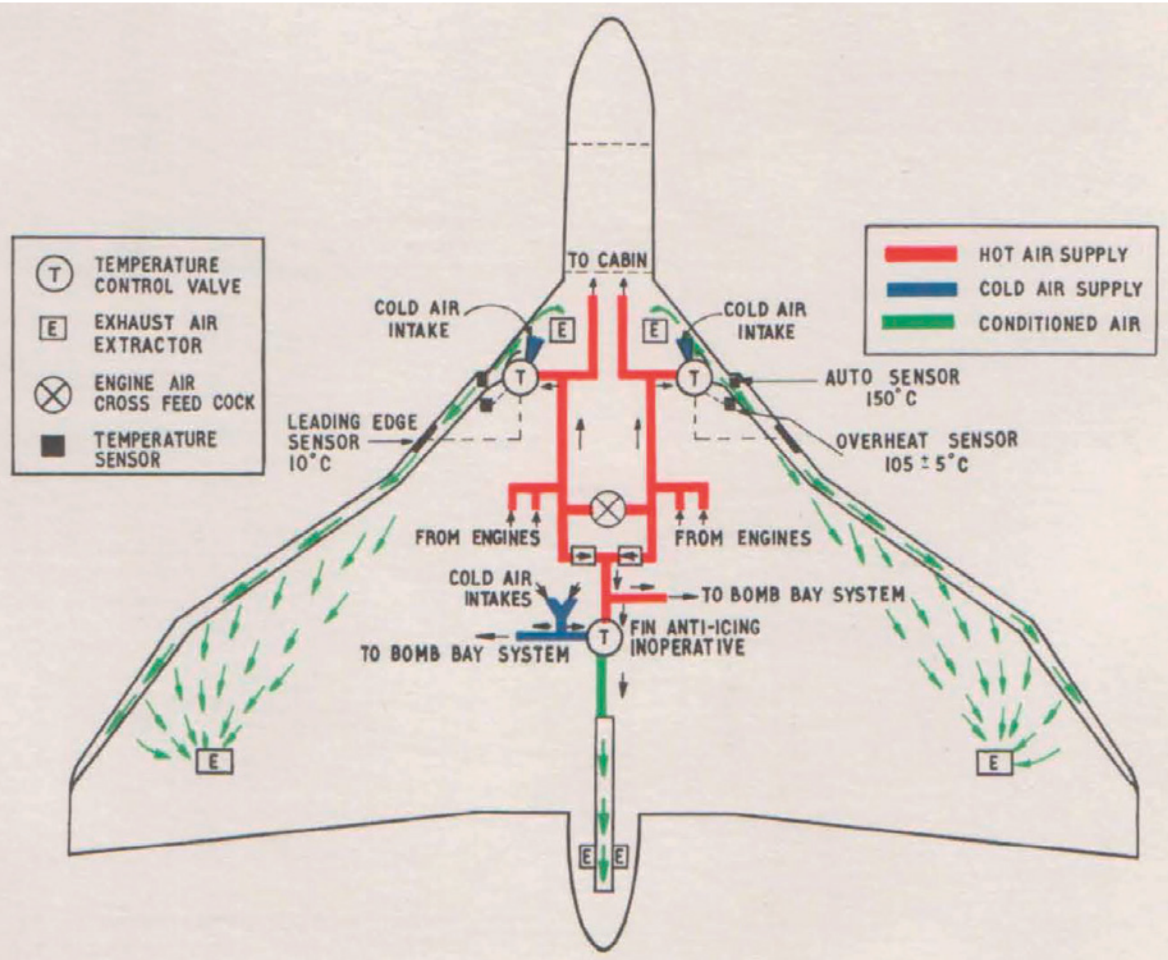
The EMERGENCY switch is a guarded three-position switch labelled OPEN/NORMAL/CLOSE. When this switch is operated, the doors are opened or closed by supplies from the hydraulic power pack and the electrical supplies are cut off from the normal selector. This switch is inoperative if the power pack is being used to charge the brakes accumulator.

A BOMB JETTISON switch is a guarded three-position switch labelled JETTISON. When this switch is operated to the JETTISON position, any payloads fitted in the bomb bay will be jettisoned. The payloads can be seen falling away from the aircraft on external cameras and can be felt through the change in the aircraft's weight.

The three-position magnetic indicator for the bomb doors is located on the centre instrument panel. It shows black when the doors are closed, white when they are open and cross-hatch when they are moving or when there is no electrical supply.

Ice protection

A thermal anti-icing system provides protection for the leading edges of the wings and fin and for the engine air intakes. Hot air from the engines and cold air from individual intakes are mixed, passed along the inside of the skin and then exhausted.



In the engine, thermal anti-icing is provided by means of hot air from the HP compressor through an electrically operated on/off valve.

The anti-icing system can be controlled either manually or automatically. The compressor anti-icing valves can be controlled either by the wing anti-icing controls or by separate on/off switches.

Gold film heating is provided for the pilots' windscreen.

The anti-icing system uses 115-volt AC from port and starboard main transformers and also 28-volt DC. The de-icing systems use 28-volt DC and 200-volt AC from No.2 busbar.

Controls

The controls are grouped on a panel at the rear of the right console. One group of controls is for the port wing and engines, one for the fin and one for the starboard wing and engines. The controls for fin anti-icing also control the anti-icing of the ECM air intake. The controls for each group consist of the following:

- AUTO/OFF/MANUAL switch
- Temperature gauge, reading from 0-200°C
- Manual heat control switch, labelled INC/DEC, spring-loaded to the central neutral position

In addition to these controls, the engine air switches must also be OPEN before hot air can be supplied to the systems.

When the AUTO/OFF/MANUAL switch is set to AUTO, the opening and closing of the hot air valve and the cold air supply are controlled by sensing elements to maintain a skin temperature of approximately 10°C and leading-edge duct air temperature at 150°C.

When MANUAL is selected, the manual heat control switch must first be held to INC until the temperature reaches 140°C and can then be adjusted as required to maintain the desired temperature.

When either AUTO or MANUAL is selected, the compressor anti-icing is also switched on. It is switched off when OFF is selected. This applies whether the engine air switches are OPEN or SHUT and, if necessary, compressor anti-icing without wing and air intake anti-icing can be selected with engine air switches SHUT.

Two separate guarded switches are provided to enable engine anti-icing to be used when the wing anti-icing is not in use. These are ON/OFF switches, one on either side of the manual heat control switches.

The windscreen heating will be operational when the entrance door is closed and the pressure-head heaters are on. Three three-position magnetic indicators for the windscreens show NORMAL when the windscreen heating is operating satisfactorily and cross-hatch when windscreen heating is off or isolated.

A HIGH/MEDIUM/LOW heat switch is located on the co-pilot's instrument panel to control the windscreen de-icing, and a DE-MIST ON/OFF switch controls the gold film heating in the windscreen.

Flight instruments

Military Flight System (MFS)

The Military Flight System (MFS) consists of:

- Twin aircraft attitude systems
- Twin compass systems
- Autopilot

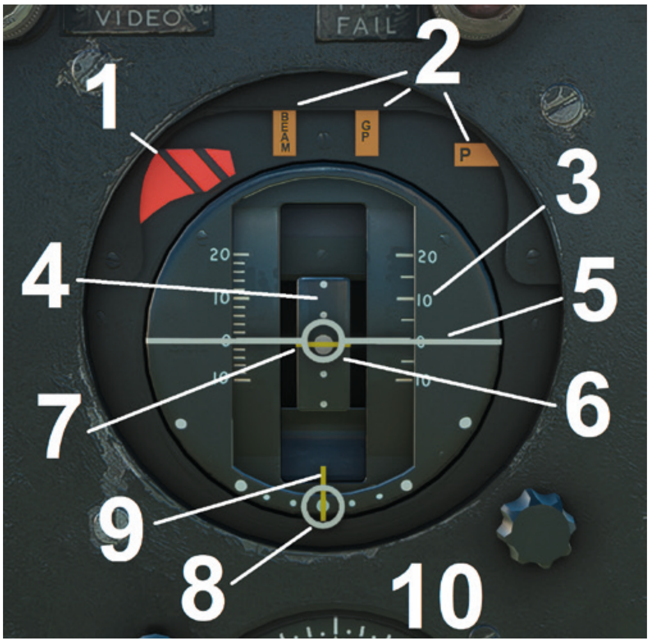
Basic information is displayed on the director horizon and the beam compass at each pilot's station. These two instruments, which replace the normal artificial horizon, gyro-magnetic compass, ILS indicator, PDI and selector and autopilot heading selector, provide flight director signals for the pilots.

ILS signals can be fed into the system, with the ILS localiser information being presented on the beam compass and the ILS glidepath information on the director horizon.

Flight director signals are fed into the director horizon, telling the pilot the attitude required to achieve the desired condition of flight. If the autopilot is in use, it is supplied with heading signals from the system.

Director horizon

Each director horizon is an artificial horizon on which the pitch and roll elements have been separated.



The various components consist of:

1. Attitude failure flag
2. BEAM and glidepath (GP) flags and a pitch director indicator (P) flag
3. Pitch scale (attitude)
4. Pitch scale (glidepath)
5. Horizon bar
6. Pitch pointer
7. Glidepath pointer
8. Bank ring-sight pointer and bank scale
9. Azimuth director pointer
10. Pitch scale setting knob

Roll signals are fed to the horizon bar, which rotates in a conventional sense to indicate bank angle. The bank ring-sight, operating at right angles to the horizon bar, moves over a scale to indicate the precise angle of bank. The scale is marked in 10° increments up to 30° and then to 60°. The azimuth director pointer moves over the same scale to indicate the difference between the current heading and the selected heading index on the beam compass. When ILS is selected, the pointer indicates deviation from the localiser.

Pitch signals are fed to the pitch pointer, which moves vertically over the pitch scale. The instrument has a linear pitch scale movement. It is calibrated against two scales ranging from 20° nose-up to 10° nose-down.

The glidepath pointer, which moves relative to the pitch scale, is controlled by ILS glidepath (glideslope) signals. When there are no glidepath signals, the needle remains over the centre dot on the pitch scale. When the pitch scale is being servo-driven and/or a selection other than central is made on the pitch selector switch, the P flag shows.

The BEAM flag is permanently in view while valid ILS localiser signals are being received. The GP flag shows when valid ILS glidepath signals are being received.

Beam compass

Each beam compass is driven by the gyro-magnetic compass system.

The beam compass:

- Acts as the heading monitor for the autopilot.
- Acts as the heading selector for both director horizons and for the autopilot.
- Shows the displacement from a selected radio beam and the aircraft heading relative to that beam.
- Can provide directional gyro information.

The various components consist of:

1. Sense switch
2. Rotatable compass scale
3. Heading pointer, with a miniature aircraft in the centre and a ring-sight pointer at the tip
4. Heading index
5. Top and bottom datum marks
6. Radio-coupled range marks
7. Radio beam displacement bar and scale
8. DG flag
9. Compass warning light
10. Setting knob

Any movement of the aircraft in azimuth is shown by the heading pointer moving over the compass card. The compass card can be rotated by holding left-click on the setting knob to pull it out and then rotating it to bring the desired heading against the datum mark at the top or bottom of the dial. The heading pointer moves with the card to indicate aircraft heading. The heading index can be moved round the compass card by middle-clicking on the setting knob to push it in and then rotating it.

The radio beam displacement bar travels horizontally over a scale on the face of the dial to indicate deviation from the beam signals.

The sense switch is used to control the coupling of localiser radio signals to the azimuth director pointer and autopilot.

An annunciator unit is provided for each half of the twin compass system. Controls consist of a COMP/DG switch, a synchronising knob and a window showing the annunciating arrows. To synchronise, turn the knob in the direction of the annunciating arrow until the arrow pulsates. The synchronising knob is also used to set the compass when it is being used as a DG.

MFS selector

An MFS selector is provided on the centre instrument panel. It has the following switches:

- COMP switch for compass selection
- Navigational selector switch
- Pitch selector switch

The COMP switch is marked with an arrow to indicate which compass system (port or starboard) has been selected to supply heading control signals to the azimuth director pointers and to the autopilot.

The navigational selector has five positions:

- **BOMB** – this setting can be used as a HDG mode when the TRACK knob is pulled UP on the autopilot controller.
- **REMOTE** – this setting can be used as a GPS mode if a flight plan is loaded in the GPS when the TRACK knob is pulled UP on the autopilot controller.
- **Central (normal)** – this setting can be used as a NAV mode to track TACANs when the TRACK knob is pulled UP on the autopilot controller.
- **LOC** – this setting can be used as a NAV mode to track VORs when the TRACK knob is pulled UP on the autopilot controller. This setting can also be used to track the localiser if an active frequency is inputted in the NAV 1 radio. With this setting selected, ILS localiser beam signals are fed into the system, indicated by the BEAM flag on the director horizon appearing in view, and the beam bar on the beam compasses will indicate the aircraft position relative to the beam.
- **GP** – this setting is identical to LOC mode but with the addition of glidepath signals fed into the system. Both the BEAM and the GP flag show on the director horizons and the glidepath pointer moves relative to the centre dot to show the relative position of the glidepath to the aircraft. The autopilot will track the glideslope when the GLIDE knob is pulled up on the autopilot controller.

The pitch selector switch controls the servo-driven functions of the director horizon pitch scales and has five positions:

- **MACH** – pitch directions are given to maintain the aircraft at the current Mach number.
- **HEIGHT** – pitch directions are given to maintain the aircraft at the altitude at which it was flying at the time of selection.
- **Central (normal)** – no pitch director signals are fed to the director horizons and the pitch scale can be adjusted to any required attitude datum by using the pitch scale setting knob.
- **APPROACH** – pitch directions are given to maintain the glidepath.
- **DATUM** – non-functional.

Power supplies

The main system is operated by 115-volt AC at 400 Hz. All control switches are operated by 28-volt DC.

Power failure is indicated by:

- Failure warning flags on both director horizons
- No compass annunciation
- No ILS BEAM or GP flag indications
- MFS pitch selector reverting to the central position

Autopilot

A Mk.10 autopilot is installed as part of the Military Flight System. The autopilot uses 115-volt AC and 28-volt DC. Power to the autopilot is controlled by a spring-loaded switch on the right console. If the autopilot has been disengaged by either pilot's instinctive cut-out switch on the rear of the control columns, the 28-volt supply will be cut off and the engage and power buttons will release. The power button will no longer hold in the up position until the reset switch has been toggled.

The autopilot control panel is located at the rear of the retractable console.

It carries the following controls:

- **TRACK** – this two-position pull-push switch can be operated using left-click to move it between OFF (down) and ON (up). With the autopilot engaged and the TRACK switch pulled up, the aircraft will track the heading set by the heading index or the ILS localiser beam, depending on the position of the navigational selector.
- **GLIDE** – this two-position pull-push switch can be operated using left-click to move it between OFF (down) and ON (up). With the autopilot engaged and the GLIDE switch pulled up, the aircraft will alter the pitch in accordance with the glidepath beam.
- **POWER** – this two-position pull-push switch can be operated using left-click to move it between OFF (down) and ON (up). When the POWER switch is pulled ON, electrical power is supplied to the autopilot system, provided that the power switch on the right console is on; this is indicated by the READY magnetic indicator changing from black to white.
- **ENGAGE** – this two-position pull-push switch can be operated using left-click to move it between OFF (down) and ON (up). When the ENGAGE switch is pulled ON, the autopilot will couple to the control surfaces; this is indicated by the IN magnetic indicator changing from black to white.
- **BOMB** – non-functional.
- **IAS/ALT** – this three-position pull/push switch can be operated using the mouse wheel to rotate it between IAS (up), OFF (middle) and ALT (down), and left-click to pull/push the switch from the IAS or ALT position to engage the selected mode. When ALT is selected, the autopilot will level off and maintain the current altitude. When IAS is selected, the autopilot will pitch the aircraft to maintain airspeed. The autopilot POWER and ENGAGE switches must be pulled ON before the altitude lock mode will function.
- **Rudder, aileron and elevator channel switches** – these two-position switches can be operated using left-click to move them between OUT (down) and IN (up). These switches control whether a particular control surface is coupled to the autopilot. Moving all three switches to the OUT (down) position will disengage the autopilot.
- **READY magnetic indicator** – displays black if power is not available to the autopilot system and displays white if electrical power is connected to the autopilot system.
- **IN magnetic indicator** – displays black if the autopilot is disengaged and white when it is engaged.
- **A/L PRIME** – non-functional.

The turn and pitch controls are at the forward end of the retractable console.

A rotary switch turns over a scale marked from 0° to 40° on either side of a neutral detent to provide turn control. To turn the aircraft, move the turn control to the desired bank angle. The control remains at the selected position and the aircraft maintains that angle of bank until the control is moved to a new position. The control is disconnected when the TRACK switch is pulled.

A DIVE/CLIMB switch provides pitch control. The switch is spring-loaded to the central (neutral) position and is moved forward to produce nose-down pitch change and rearwards to produce nose-up pitch change.

The trim indicator on the centre instrument panel is in the form of a side view of the aircraft and indicates any out-of-trim condition in pitch. The indicator also contains flags to show when the autopilot is ready and engaged.

The artificial feel indicator on the centre instrument panel shows black during normal flight conditions, ILS during approach conditions (with TRACK and LOC & GP selected), and white if any of the autopilot aileron or rudder channels disengage.

Pressure heads

The two pressure (pitot) heads are located below and on either side of the nose of the aircraft and are electrically heated. The heaters use 115-volt AC from one phase of the 200-volt supply (No.2 busbar port, No.4 busbar starboard). The supply is controlled by a switch on the right console.

A magnetic indicator at the top of the centre panel shows white when the heater is switched off.

Pressure-operated instruments

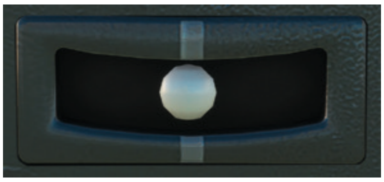
Each pilot has the following pressure-operated instruments on their instrument panel:

- Airspeed indicator (ASI)
- Mach meter
- Vertical speed indicator (VSI)
- Altimeter

The 1st pilot's panel features a standby artificial horizon.

Miscellaneous instruments

An accelerometer is fitted on the left of the centre instrument panel. The maximum and minimum readings can be reset by pressing the PUSH TO SET knob.



Each pilot has a bubble-type slip indicator at the bottom of their instrument panel.

A hinged arm is fitted underneath the aircraft tail cone and two red tail clearance lights are fitted to the coaming. If the arm touches the ground, during a landing for example, the lights will illuminate to warn that the tail is too close to the ground.

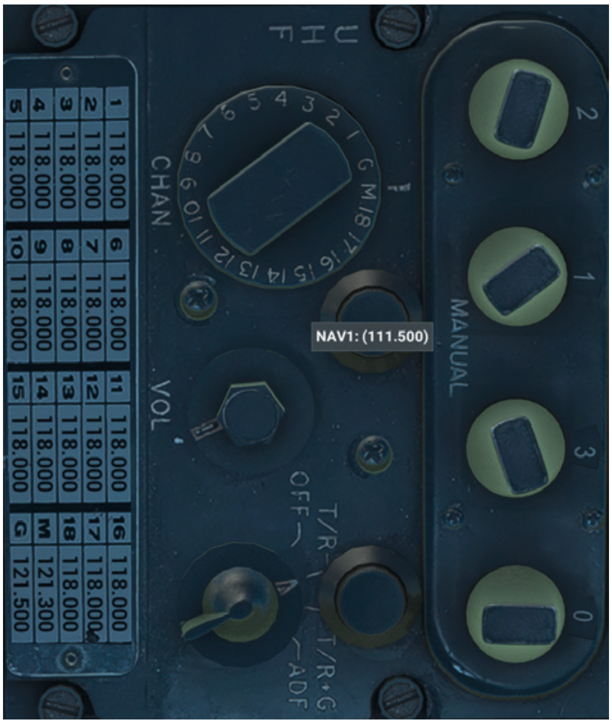
Radios

V/UHF

A UHF radio is fitted on the left console. As the simulator does not provide support for UHF radios, it has been repurposed as a VHF radio which controls COM 1 and NAV 1.

The radio has the following controls:

1. A 20-position rotary switch giving a selection of 18 preset channels, the guard frequency (G – 121.50) and MANUAL.
2. Four digit selectors – only operative when MANUAL is selected on the 20-position rotary switch. Rotate each selector to set a COM 1 frequency. As only four digit selectors are available, the first digit (which is always 1) in the COM 1 frequency is not selectable. For example, set 2830 to tune 128.30.
3. Volume control
4. Function switch
5. Two selectors for setting a NAV 1 frequency (in the real aircraft this would be set by the rear crew).



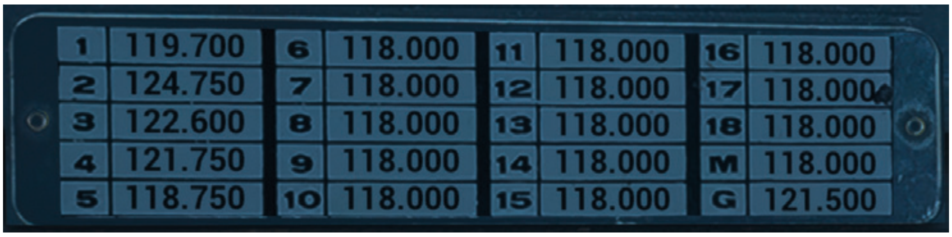
A tooltip will appear when your mouse cursor is placed over any of the four digit selectors or two NAV 1 selectors, showing the currently tuned COM 1 or NAV 1 frequency.

MSFS tooltips can be enabled by going to Options > General Options > Accessibility > Instrument Name Tooltips.

Alternatively, the frequency tuned into each of the aircraft's radios is displayed and can be edited on the Radio menu of the EFB.

The 18 preset channel frequencies are set to 118.000 by default but can be set to frequencies of your choice by selecting M (Manual) mode, tuning the desired frequency by using the digit selectors and then left-clicking one of the 18 preset fields.

The M (Manual) field shows the current tuned frequency and the G (Guard) field shows the standard guard frequency, therefore new frequencies cannot be saved to these fields.



Radio compass (ADF)

A radio compass is fitted to the co-pilot’s instrument panel, showing the relative bearing to the selected NDB.

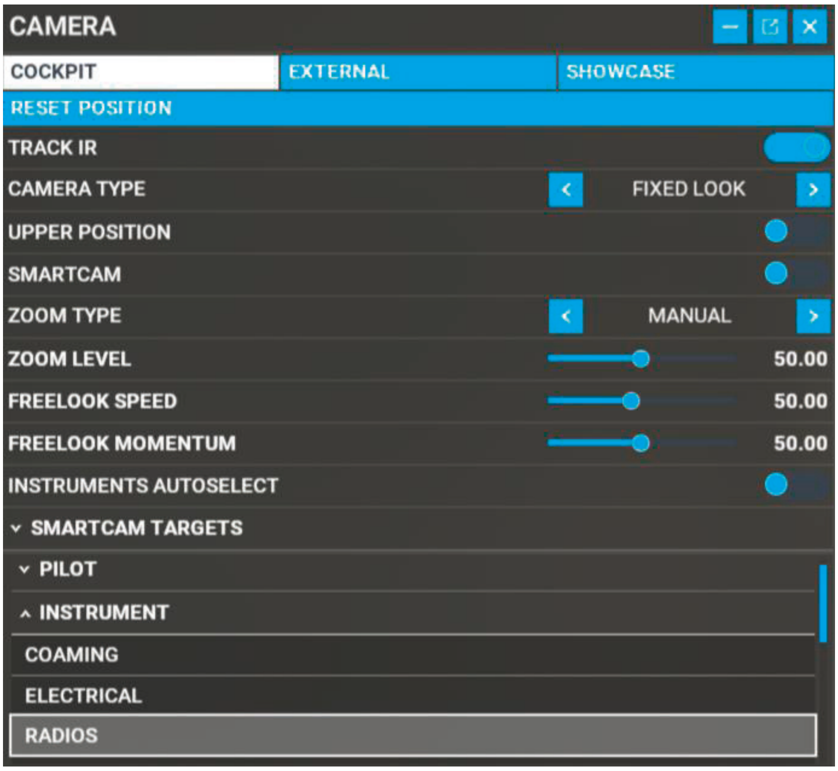
As the radio compass controller is fitted to the rear crew compartment in the real aircraft, in this simulation the frequency can be set using the HF, CONF I/C and WARN RX knobs on the co-pilot’s station box. A tooltip will appear when your mouse cursor is placed over any of the three knobs, showing the currently tuned ADF frequency, and the ADF frequency can also be viewed and edited via the Radio menu on the EFB.

TACAN indicator

A TACAN indicator is fitted to the centre instrument panel, showing the bearing and distance to the selected beacon.

TACAN ground stations are supported by Microsoft Flight Simulator and the TACAN channel and mode can be found on the world map or on airport charts.

The TACAN channel can be changed on the Navigator's TACAN panel in the rear cockpit.



The TACAN panel can be accessed via multiple methods:

MSFS camera system: Open the MSFS Camera menu by moving the mouse to the top centre of the screen to open the MSFS toolbar, then click on the camera icon. With the MSFS Camera menu open, the panel cameras can be selected by going to COCKPIT, INSTRUMENT and then selecting RADIOS. To return to the forward cockpit, either repeat the above process and select a COCKPIT camera, or press the [F] key on your keyboard to reset the camera back to the default position.

Panel screws: Hidden clickspots are provided on screws on the main instrument panel and at the bottom of the rear cockpit panels to swap the camera between the relevant views.

EFB camera controls: Various camera position can be accessed by clicking on the respective box at the bottom of the EFB's Aircraft page. The EFB remains at all four cockpit positions. In the AEO and Navigator positions, the EFB is located to the side of the panel and can be brought into view by clicking on the EFB's bezel.

Radio altimeter

A radio altimeter is installed on the Captain's instrument panel.

It can measure the height of the aircraft above the surface up to a maximum of 5,000 ft. Height measurement is in two ranges: 0-500 ft and 0-5,000 ft. The controller is located on the left console. Power is supplied by 115-volt AC and 28-volt DC.

The controller has the following controls:

- ON/OFF switch
- Range selector
- Limit lights selector
- Spring-loaded test switch

The altimeter is ready for use after it is switched on. When the test switch is operated, the needle moves to 65 feet.

A limit indicator consisting of three coloured lights is located on the co-pilot's panel.

Left instrument panel

1. MFS annunciator
2. Oxygen flow indicator
3. White floodlighting switch
4. Windscreen wiper switch (left and centre wipers)
5. Airspeed indicator
6. Auto-throttle comparator lights (inoperative)
7. TFR video light
8. Mach meter
9. TFR warning light
10. ILS marker light
11. Radio altimeter
12. Director horizon
13. TFR failure light
14. Vertical speed indicator (VSI)
15. Altimeter
16. Crew escape lights
17. Beam compass
18. Standby artificial horizon and slip indicator
19. DME distance indicator (NAV 1)
20. Clock

Centre instrument panel

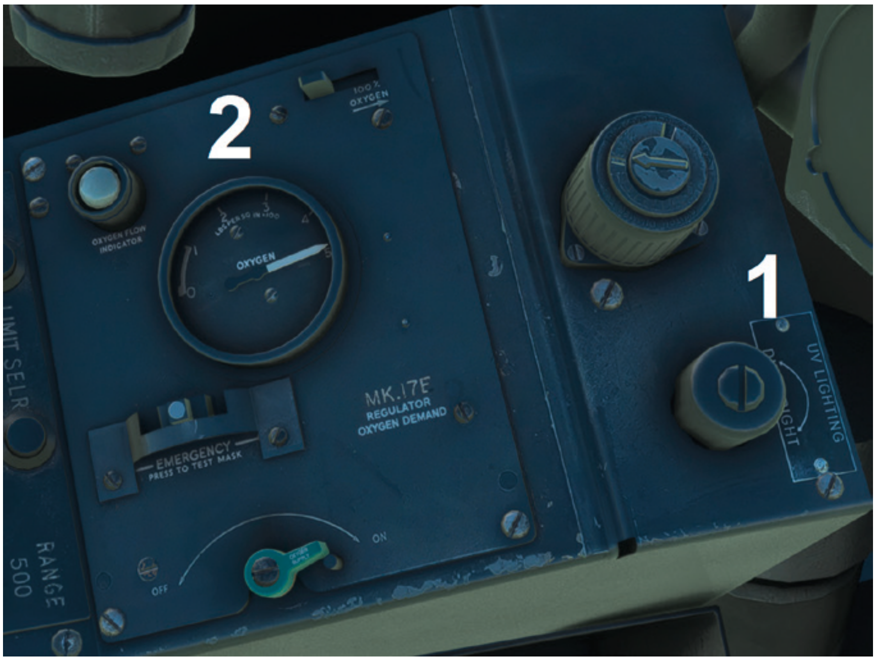
1. LP cocks
2. Main warning light (x2) – illuminates when any of the PFCs, feel units or auto-stabilisers fail.
3. PFC warning indicator
4. Artificial feel indicator
5. Auto-stabiliser indicator
6. Airbrakes position indicator
7. Alternator failure warning light
8. Bomb doors position indicator
9. Canopy unlocked indicator
10. Entrance door unlocked indicator
11. Pressure-head (pitot) heater indicator
12. Accelerometer (G-meter)
13. Control surfaces position indicator
14. MFS selector
15. Jet pipe temperature (JPT) gauges
16. Tail parachute switches – move down to stream (deploy) the parachute; move up to jettison the parachute.
17. Autopilot trim indicator
18. Fuel pressure indicators
19. Engine governor control indicator (inoperative)

20. RPM gauges
21. TACAN indicator (shows bearing to NAV 1 VOR)
22. Oil pressure gauges
23. Hydraulic power pack switch
24. Undercarriage control buttons
25. Hydraulic triple pressure gauge
26. Undercarriage position indicator
27. CG indicator
28. CG check button

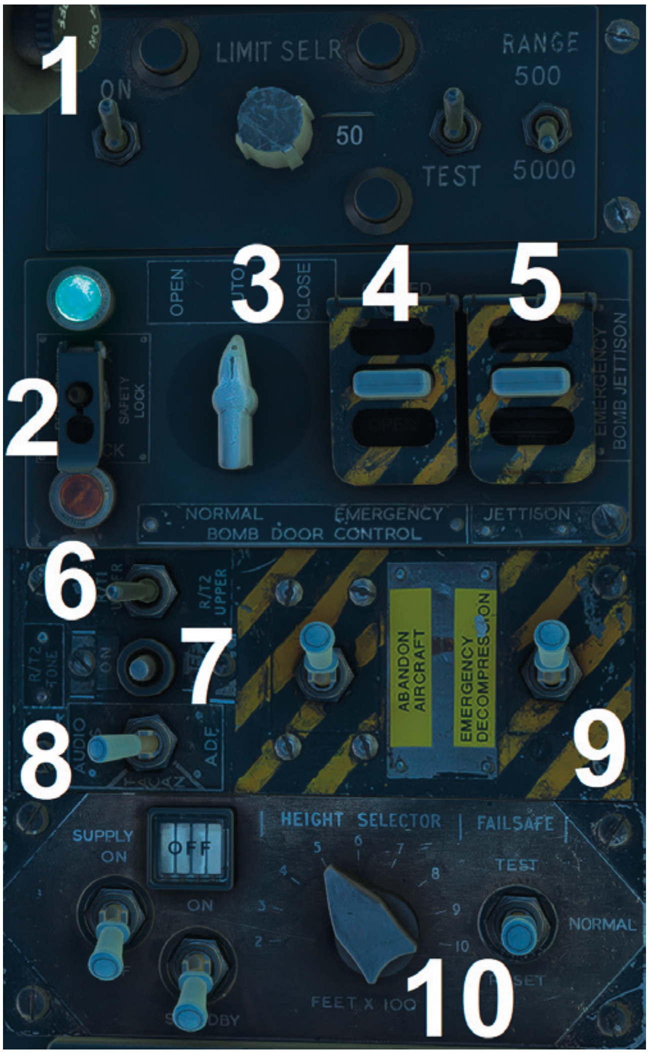
Right instrument panel

1. Bomb bay tanks fire warning light
2. TFR warning light
3. Wing/fuselage tank fire warning lights and extinguisher buttons
4. ILS marker light
5. Radio altimeter limit lights
6. MFS/TFR switch
7. TFR video light
8. Mach meter
9. Airspeed indicator
10. Director horizon
11. TFR failure light
12. Windscreen overheat warning light
13. Windscreen de-ice switch
14. Windscreen demist switch
15. Windscreen wiper switch (right wipers)
16. Altimeter
17. Vertical speed indicator (VSI)
18. Fuel flow indicator – indications for individual engines can be obtained by pressing the fuel flow engine selector push-buttons on the retractable console.
19. ADF indicator
20. Beam compass
21. Flow meter total flow indicator
22. Slip indicator
23. MFS annunciator
24. Flow meter reset switch
25. Oxygen flow indicator
26. White floodlighting switch
27. Co-pilot's station box

Left console

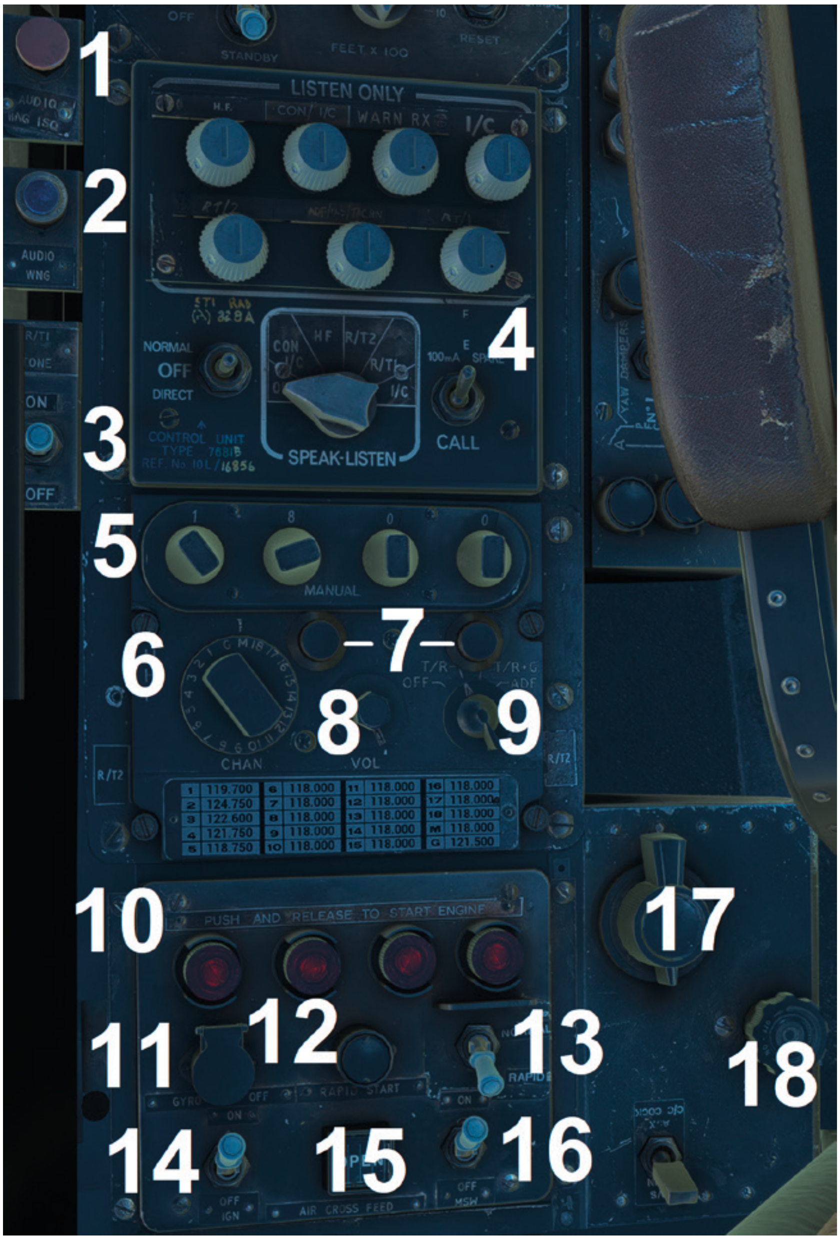


1. UV lighting dimmer switch
2. Oxygen regulator



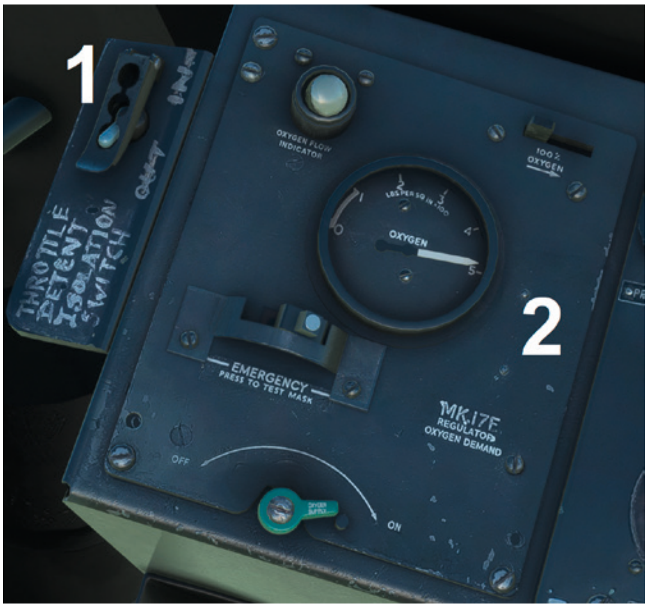
1. Radio altimeter controller
2. Store safety lock and warning lights
3. Bomb doors normal control
4. Bomb doors emergency control
5. Bomb jettison switch
6. Aerial change-over switch
7. RT2 tone switch
8. ILS/TACAN/ADF audio switch
9. Abandon aircraft and emergency decompression switches
10. TFR controller

1. PFC and artificial feel start buttons (x3)
2. Yaw damper selector switch
3. Comparator reset button
4. PFC stop buttons (x10)
5. Pitch damper control buttons (x4)
6. Mach trimmer reset (x2) and master control buttons
7. Artificial feel warning cancel buttons (x3)
8. Artificial feel lock switch and indicator light



1. Audio warning isolation button
2. Audio warning test button
3. RT1 tone switch
4. Captain’s station box
5. V/UHF radio COM frequency selectors
6. V/UHF radio COM channel selector
7. V/UHF radio NAV frequency selectors
8. V/UHF radio volume knob
9. V/UHF radio mode selector
10. Individual start push-buttons
11. Gyro hold-off push-button
12. Rapid start push-button
13. Rapid/normal start selector switch
14. Ignition switch
15. Air cross-feed indicator
16. Start master switch
17. Air-ventilated suits temperature control
18. Air-ventilated suits flow control

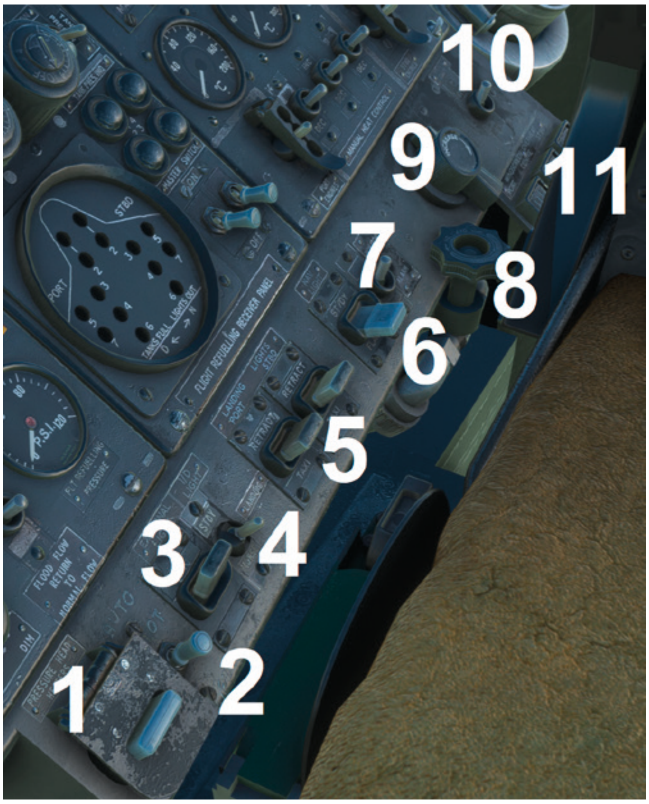
Right console



1. Throttle detent isolation switch
2. Oxygen regulator

1. Cabin pressure selector
2. Temperature control valve position indicator
3. Cabin temperature selector
4. Engine air switches
5. Cabin temperature control switch
6. Cold air unit overspeed indicator
7. Cabin air switches
8. Ram air valve position indicator
9. Ram air valve switch
10. UV lighting dimmer switch
11. Flood flow switch (inoperative)
12. AAPP air bleed indicator
13. AAPP cabin air bleed switch
14. Abandon aircraft switch
15. Air-to-air refuelling pressure gauge

1. Refuelling probe lighting dimmer switches
2. Nitrogen purge switch
3. Tank pressurisation switch
4. Tank pressurisation indicators
5. Air-to-air refuelling indicator
6. Air-to-air refuelling master switches
7. Airframe anti-icing auto/manual switches
8. Anti-icing temperature gauges
9. Engine anti-icing switches
10. Anti-icing manual heat control switches



1. Pressure head (pitot) heater switch
2. Autopilot power switch
3. External lights master switch
4. Identification light steady/Morse switch
5. Landing/taxi lamp switches
6. Navigation lights steady/flash switch
7. ECM monitor/alarm control
8. Air-ventilated suits flow control
9. Air-ventilated suits temperature control
10. Air-ventilated suits master switch
11. Windscreen overheat indicators

Control column

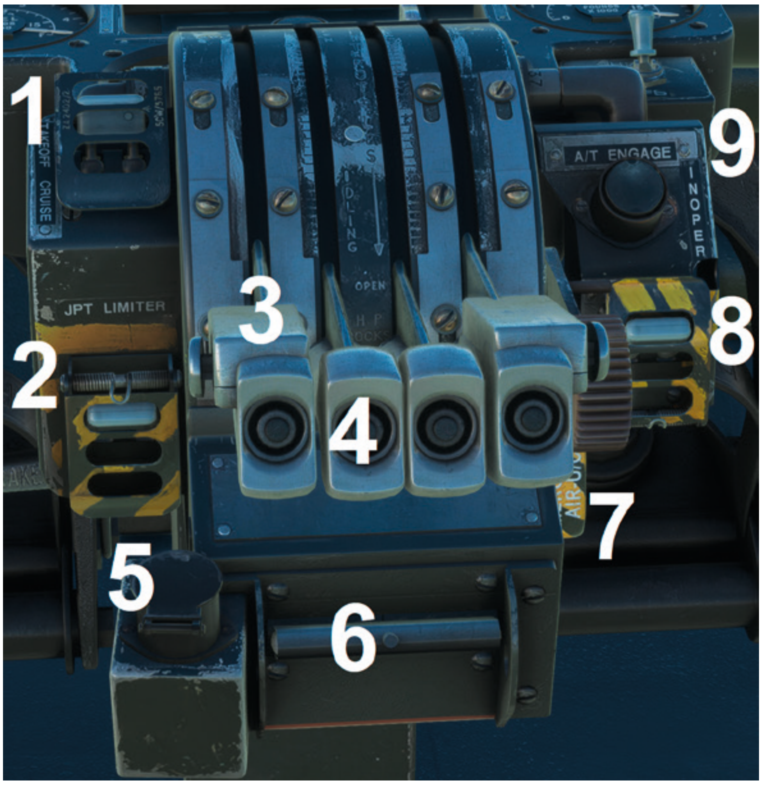
1. Nose-wheel steering engage button
2. Elevator and aileron feel relief switch
3. Aileron and elevator trim switch
4. Press-to-transmit switch

Upper cockpit

1. E2B compass
2. Tail clearance warning lights
3. RAT release handle
4. Engine fire warning lights and extinguisher buttons

Throttle quadrant

1. Anti-dazzle lamp switch
2. No.1 engine group fuel contents gauge
3. Parking brake lever
4. No.2 engine group fuel contents gauge
5. Cabin altimeter
6. Rudder feel relief push-button
7. Rudder trim switch
8. No.3 engine group fuel contents gauge
9. No.4 engine group fuel contents gauge
10. HRS/MFS switch

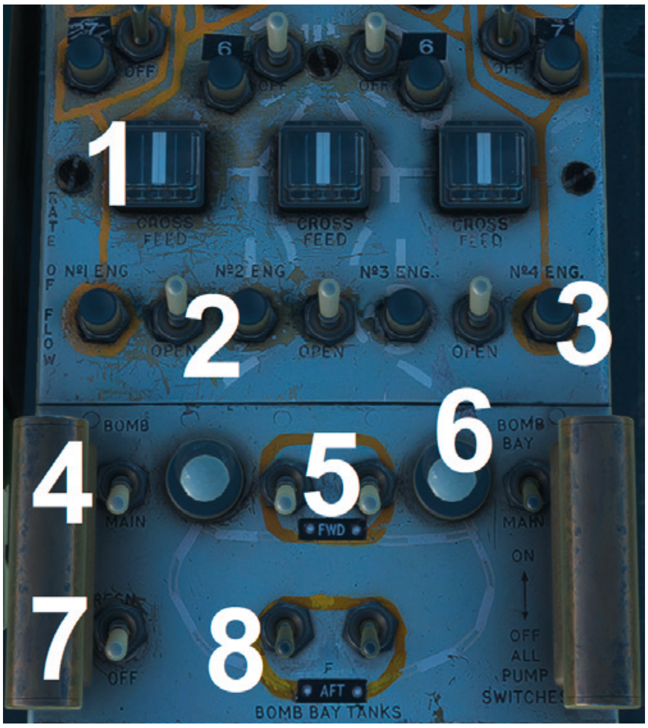


1. RPM governor switch
2. JPT limiter switch
3. Throttle levers
4. Engine relight buttons
5. Pilot's bomb release control
6. Airbrakes selector switch
7. Undercarriage emergency lowering control
8. Airbrakes normal/emergency switch
9. Auto-throttle engage push-button (inoperative)

Retractable console

The console can be retracted and extended by clicking on the handle at the rear.

1. Autopilot turn control
2. Autopilot pitch control
3. Emergency trim control
4. Fuel CG/transfer switches
5. Flight refuelling lateral CG control switch
6. Auto/manual switches
7. Tank contents push-buttons
8. Tank pump switches

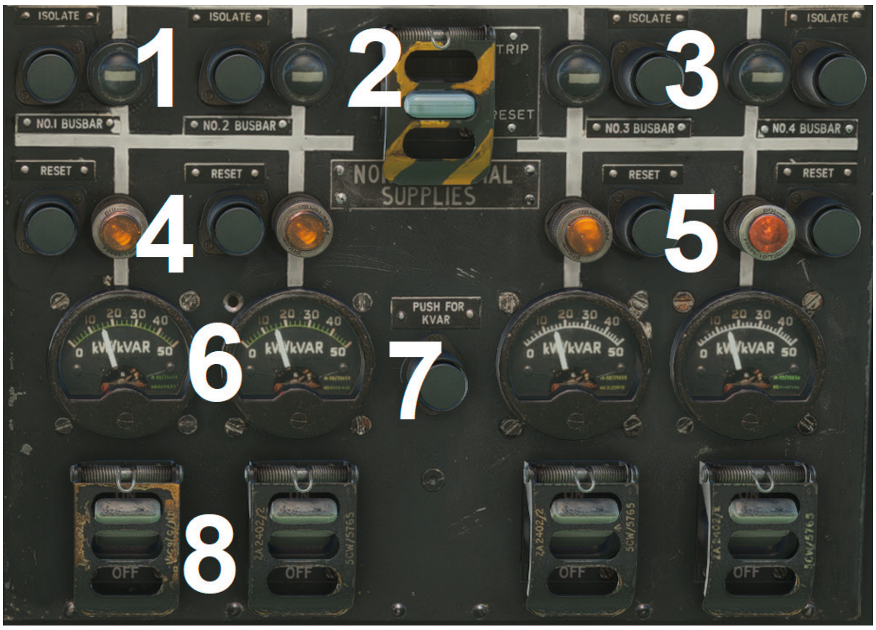


1. Cross-feed cock position indicators
2. Cross-feed cock switches
3. Fuel flow engine selector push-buttons
4. Bomb bay / main tank selector switches
5. Pump switches for forward bomb bay tank
6. Bomb bay fuel pressure indicators
7. Bomb bay tanks pressurisation switch (inoperative)
8. Pump switches for rear bomb bay tank

1. Autopilot track switch
2. Autopilot glide switch
3. Autopilot power switch
4. Autopilot channel engage switches (aileron, rudder and elevator)
5. Autopilot READY indicator
6. Autopilot Autoland switch (inoperative)
7. Autopilot IN indicator
8. Autopilot bomb switch
9. Autopilot IAS/altitude switch
10. Autopilot engage switch

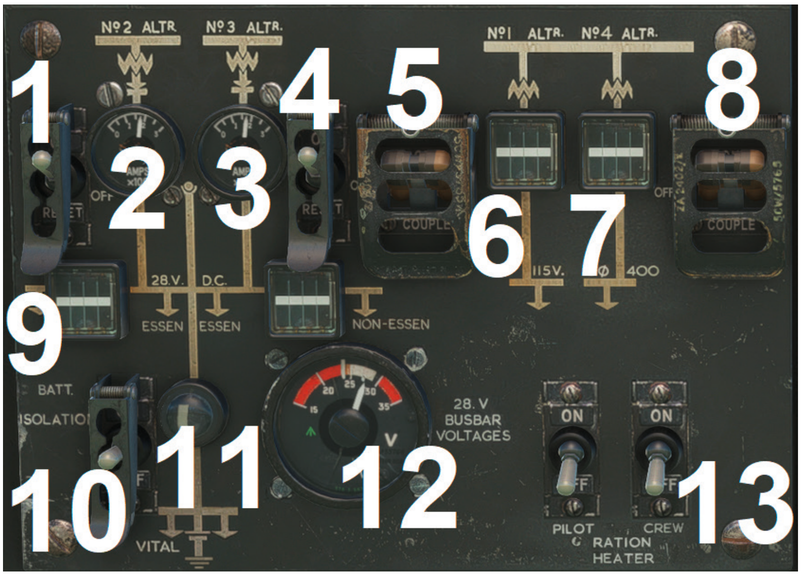
Alternator control panel

1. Incoming alternator voltmeter
2. RAT field switch
3. Extra supplies trip button
4. RAT test push-button
5. Alternator selector switch
6. AAPP test button
7. Incoming alternator frequency meter
8. Synchronising busbar voltmeter
9. RAT synchronising magnetic indicator
10. Alternator failure red warning light
11. AAPP synchronising magnetic indicator
12. Synchronising busbar frequency meter
13. AAPP synchronising button



1. Alternator synchronising magnetic indicators (x4)
2. Non-essential supplies reset switch
3. Alternator isolating buttons (x4)
4. Alternator warning lights (x4)
5. Alternator reset buttons (x4)
6. Alternator KW/KVAR meters (x4)
7. KVAR reading selector button
8. Alternator on/off switches (x4)

Secondary supplies panel



1. Port TRU switch
2. Port TRU ammeter
3. Starboard TRU ammeter
4. Starboard TRU switch
5. Port main transformer switch
6. Port main transformer magnetic indicator
7. Starboard main transformer magnetic indicator
8. Starboard main transformer switch
9. Load-shed magnetic indicators
10. Battery isolation switch
11. Battery magnetic indicator
12. DC voltmeter
13. Ration heater switches

AAPP control panel

1. JPT gauge
2. Fuel level magnetic indicator
3. Oil pressure gauge
4. Starter button
5. LP cock switch
6. HP cock override switch
7. Ignition isolation switch
8. Fire warning light and extinguisher button
9. Fire warning light test button
10. Oxygen and relight switch
11. Master switch

AIRCRAFT EQUIPMENT

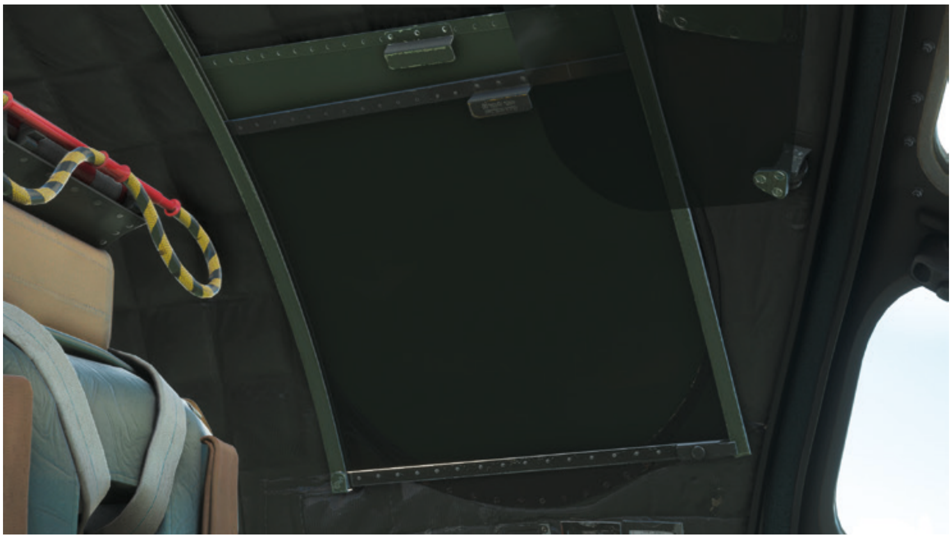
Various pieces of equipment can be fitted and operated on the Vulcan that may not be covered elsewhere in this manual. Unless otherwise stated, most of this equipment can be fitted to or removed from the aircraft by using the Electronic Flight Bag (EFB). For further details on the EFB, please see the dedicated EFB manual.

Cockpit

The pilot's and co-pilot's ejector seats are located on a raised platform at the front of the cockpit. The seats are fixed in position and cannot be adjusted. To allow the two pilots to get in and out of their seats, the centre fuel console can be pushed forward and retracted below the throttle quadrant. The console can be extended/retracted by clicking on the handle on the aft side of the console.

In addition, two adjustable armrests are fitted to both pilots' ejector seats. These can be raised or lowered by clicking on the respective armrest.

Five sun visors can be found stowed on the roof above the pilots’ seats and can be lowered to cover the windscreen and thus reduce the intensity of the light entering the cockpit. Three of these sun visors are used to cover the front windscreens and are hinged at the top. The other two are installed on rails and can be slid down to cover the side windows.



Anti-flash screens are also fitted to each of the side windows. These can be slid down to completely block any light entering the cockpit through these windows. These screens were intended to be used to protect the pilots’ eyesight after a nuclear blast.

Ejector seat pins can be removed from the ejector seats by clicking on one of the pins. Once removed, the pins will be stowed in in the safety pin stowages on the left and right side walls of the cockpit. Clicking on the pins whilst they are in the stowages will place the pins back into the ejector seats.

An animated co-pilot can be toggled on/off by using the COPILOT option on the EFB. The co-pilot’s sun visor will close in bright sunlight and open in lower light conditions. The pilot will automatically move between the Captain and co-pilot seats depending on the camera position set in the MSFS camera menu or on the EFB.

External

Various pieces of equipment can be fitted to and operated on the exterior of the aircraft by using the Aircraft page on the EFB.

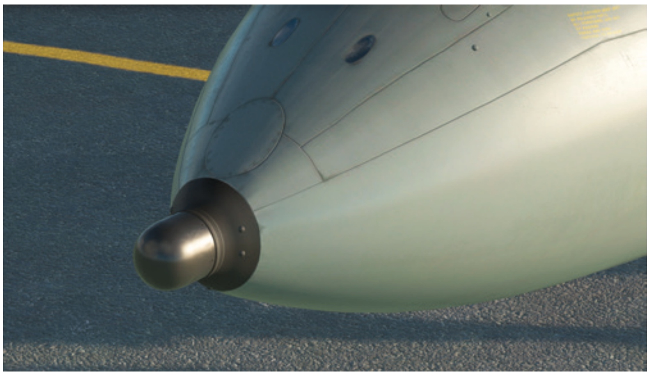
The K2 TANKER option on the EFB will toggle on/off the hose drum unit (HDU) on the rear of the aircraft and will also toggle on/off the three CYLINDER TANK fuel tanks in the bomb bay.

With the HDU fitted and the aircraft in the air, the hose can be extended using the K2 HOSE option on the EFB. Three lights on the HDU indicate to the receiving aircraft if they are clear for contact. Red lights mean do not make contact, or disconnect immediately. Amber lights mean stand by for contact. Green lights indicate that fuel is flowing.

Each livery included in this Vulcan software will automatically be fitted with the correct engine type. However, the 201 ENGINES option on the EFB can be used to toggle between the Olympus 301 and 201 engine nozzle types.

Note: *Although two sound sets are included in our simulation of the Vulcan (one for the Olympus 301 engines, and one for the Olympus 201 engines), toggling the engine nozzle types on the EFB will not immediately change the sound set used. In order to change sound sets a restart of the flight is required.*

The air-to-air refuelling probe on the nose of the aircraft can be toggled on/off using the NOSE PROBE option on the EFB.



Likewise, the Terrain Following Radar (TFR) dome located on the tip of the aircraft' nose can be toggled on/off using the TFR DOME option on the EFB

Electronic Countermeasure (ECM) panels on the tail and between engines 3 and 4 can be toggled on/off using the ECM option on the EFB.

When a Blue Steel missile is loaded in the bomb bay, another ECM panel will automatically be fitted between engines 1 and 2. A second ECM panel was necessary for aircraft carrying Blue Steel missiles as the missile would partially block the viewing angle of the ECM aerials, thus jeopardising the aircraft's safety. Two ECM panels allow for full 360-degree coverage around the aircraft.

When flying the Vulcan in the Maritime Radar Reconnaissance (MRR) configuration, the MRR AERIALS option on the EFB will toggle on/off the aerials specific to MRR-configured aircraft.

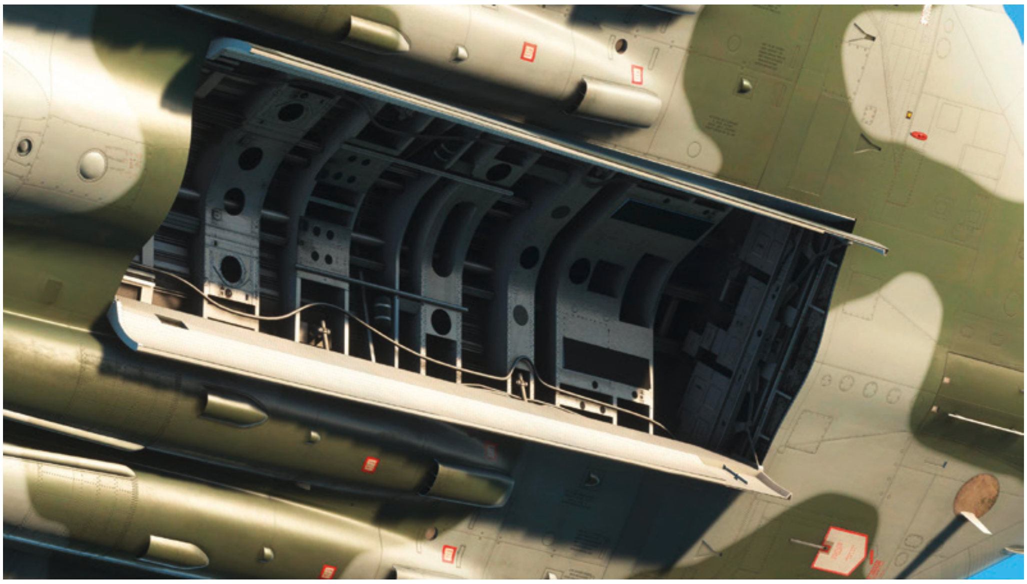
During XH558's return to flight between 2007 and 2015, in order to comply with modern regulations the aircraft was fitted with various aerials that were only ever fitted to this aircraft. The 558 AERIALS option on the EFB will toggle these aerials on/off.

The crew entrance door can be opened and the ladder extended by using the CREW DOOR option on the EFB.

Two MRR pods can be fitted externally, one under each wing. These pods were built using modified external fuel tanks from Sea Vixen aircraft and were used for Maritime Radar Reconnaissance sorties. The pods can be fitted by clicking on the respective field on the payload configurator on the EFB.

Up to four AGM-45 Shrike missiles can be fitted externally, two on each missile rack under each wing. These anti-radiation missiles were covertly shipped by the United States to the RAF for use during the Falklands War of 1982. The missiles can be fitted by clicking on the respective field on the payload configurator on the EFB.

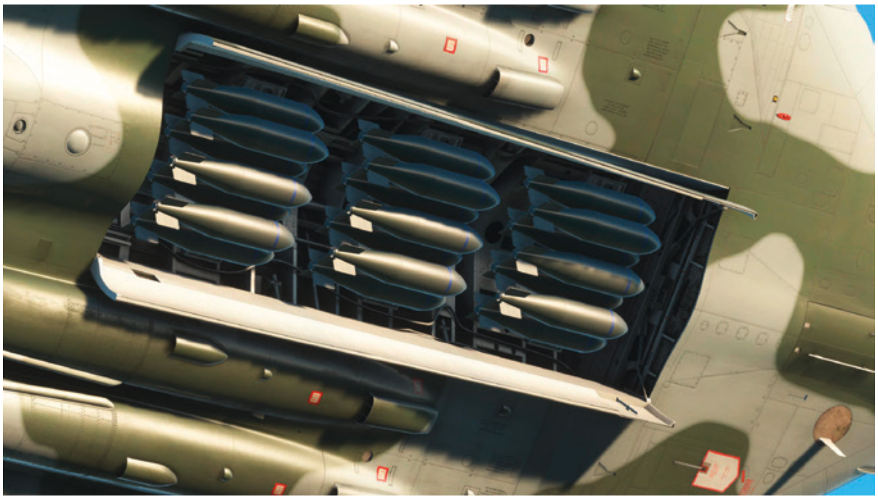
Bomb bay



The bomb bay doors can be opened/closed by using the BOMB DOORS option on the EFB, the bomb door controls in the cockpit, or by using the TOGGLE TAIL HOOK HANDLE control assignment. They default to the open position when loading the aircraft in a cold and dark state.

The Vulcan can carry a variety of conventional and nuclear payloads, the majority of which are loaded in the bomb bay by using the payload configurator on the Aircraft page of the EFB.

The Blue Steel, air-launched, rocket-propelled, nuclear armed stand-off missile was built specifically to be launched by the Vulcan and the V-bomber force. The missile was too large to fit inside the Vulcan's internal bomb bay and therefore modifications were made to the bomb bay doors to allow the missile to be fitted partially externally. A large ventral fin on the rear of the missile retracts automatically when the landing gear is selected down in order to provide sufficient ground clearance when on the ground. The missile remained in service with the RAF between 1963 and 1970, serving as the UK's nuclear deterrent.



Twenty-one Mk13 1,000 lb bombs can be loaded in the Vulcan's bomb bay, with seven bombs on each of the three bomb racks. These unguided, free-fall bombs are most famous for being the bombs used in the 'Black Buck' missions to strike targets on the Falkland Islands during the Falklands War of 1982.

One WE.177 free-fall, gravity nuclear bomb can be fitted in the mid bay. The nuclear bomb, which has a blast yield of up to 450 kilotons, entered RAF service in 1966 and remained in service throughout the Vulcan's remaining service life, eventually being retired in 1998.

Two saddle tanks can be fitted in the bomb bay, one in each of the forward and aft bays. These fuel tanks were designed to be used in conjunction with the Blue Steel missiles, hence their unusual shape.

Three cylinder tanks can be fitted in the bomb bay, one in each of the forward, mid and aft bays. These tanks were primarily fitted to the K.2 tanker variant of the Vulcan, increasing the amount of fuel that could be transferred to receiving aircraft.

Ground equipment

Ground equipment can be enabled and connected to the aircraft using the GND POWER and PALOUSTE options on the EFB.

The Houchin ground power unit (GPU) can be used to provide electrical power to the aircraft while on the ground. The GPU is parked underneath the port wing and is plugged into the aircraft just aft of the bomb bay.

The Palouste compressor is used to provide compressed air to the engine air starter motors, facilitating engine starting while on the ground. The Palouste is parked underneath the starboard wing and the air supply hose is connected to the aircraft just aft of the starboard landing gear.

The aircraft can also be fitted with wheel chocks by using the CHOCKS option on the EFB.

The COVERS option on the EFB will fit engine intake and exhaust covers when the engines are shut down.

FLYING THE VULCAN

In this tutorial flight we will be departing from Doncaster Sheffield, the former V-Bomber base of RAF Finningley in South Yorkshire, UK. We will then be flying south to RAF Fairford, home of the Royal International Air Tattoo, the largest military airshow in the world. After departure from Doncaster we will be flying south towards the former V-Bomber base of RAF Wittering, then heading south-west and flying over the town of Northampton and overhead RAF Brize Norton before approaching RAF Fairford from the east to land on runway 27.

Covering approximately 130 nautical miles, this short flight is the ideal length for learning about the essential systems on board the Vulcan.

Here are the details for today's flight:

EGCN – WIT (123X) – DTY (116.40) – BZN (56X) – EGVA

Estimated time en route: 40 minutes

Route distance: 130 nautical miles

Departure time: 1200 (local time)

Weather: Few clouds

Now that we are prepared for the flight, we can proceed to the cockpit to begin our pre-flight checks. To load up the Vulcan tutorial flight, follow these steps:

1. Start Microsoft Flight Simulator.
2. Click **World Map**.
3. Click **More** and then click **Load/Save**.
4. Choose **Load From This PC**.
5. Select **Just Flight Vulcan Tutorial Flight** from the list of saved flights.
6. Click on **OK**.
7. Click **Fly**.

You should now find yourself sitting in the cockpit at a parking position on the north side of Doncaster Sheffield. As we have started the flight at a parking position, the aircraft has automatically loaded in a 'cold and dark' state, with all cockpit systems switched off, just as you would find the aircraft prior to the first flight of the day.

Beginning in this configuration means we will need to spend some additional time setting up the cockpit, but doing so will allow you to learn a considerable amount about the features and functions on board this aircraft.

If you wish to skip ahead and start this tutorial flight with more systems already set up, then you can load the aircraft in a READY FOR START or READY FOR TO state via the EFB.

This tutorial will cover the necessary steps for you to get from point A to point B, but it will not explore each system in depth. Please refer to the rest of this manual for details of each system.

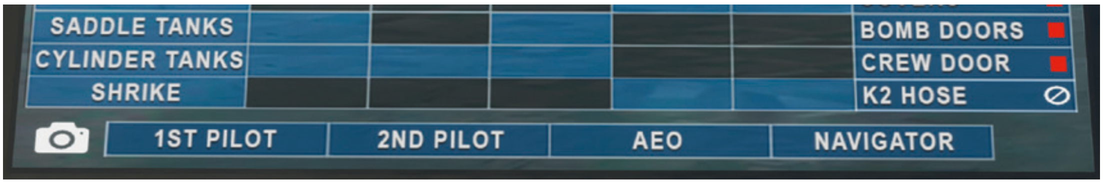
For today's flight we will be navigating using the 'traditional' methods on which the Vulcan cockpit was developed: VOR, TACAN, ADF and ILS.

Getting started

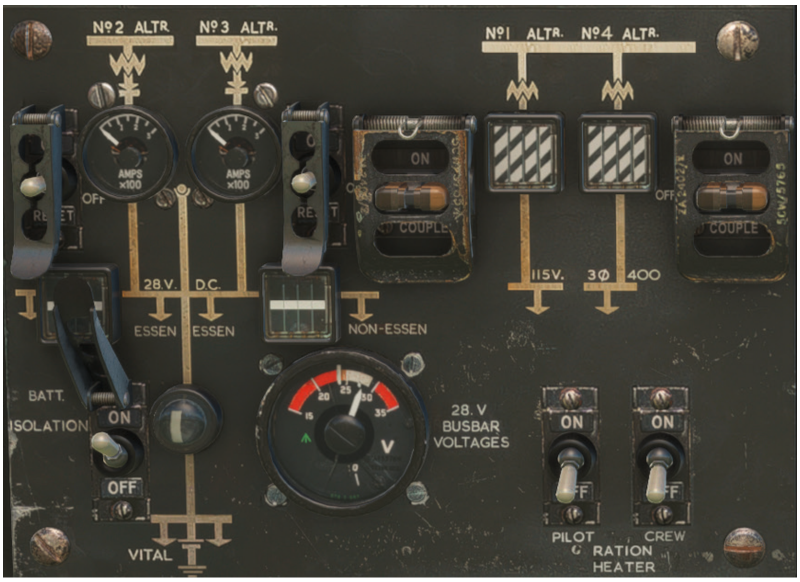
We will begin our pre-flight checks on the oxygen panel on the forward left side console. Press and hold the oxygen regulator test button and check for the white flow magnetic indicator to confirm the flow of oxygen, then switch **ON** the oxygen supply.

Repeat this process for the co-pilot's oxygen panel.

We now need to move into the AEO's (Airborne Electrical Operator's) position in the rear cockpit. We can do this by a few different methods, but for this tutorial flight we will use the camera options at the bottom of the Aircraft page on the EFB.



Once at the AEO's position, ensure that all switches and controls are in the **OFF** position before then switching **ON** the battery. Confirm a minimum of 24V is indicated on the voltmeter.



Moving across to the alternator control panel (ACP), open the NON-ESSENTIAL SUPPLIES switch guard and move the switch to **TRIP**. Confirm that the two non-essential mechanical indicators on the SSP show discontinuity (vertical line) before moving the NON-ESSENTIAL SUPPLIES switch to **RESET** and closing the guard, confirming that the two mechanical indicators have returned to their normal in-line indication.

We can now return to the front cockpit by clicking on the bezel of the EFB and then clicking the 1ST PILOT camera option.

Connect the ground equipment by clicking the GND POWER and PALOUSTE options on the Aircraft page of the EFB.

Swapping briefly to the exterior camera should confirm that the Houchin ground power unit (GPU) and Palouste compressor are connected to the aircraft.

Returning back inside the aircraft and to the rear cockpit, we should see an increased voltage on the voltmeter, which will now be indicating approximately 28V.

We can now prepare the airborne auxiliary power plant (AAPP) panel for AAPP start later in this tutorial. Set the LP cock to **OPEN**, test the fire warning, set the OXYGEN & RELIGHT switch to **OFF**, ensure the fuel level mechanical indicator is displaying **HIGH** and set the MASTER SWITCH to **OFF**.

Moving back to the front cockpit, we can now run through some pre-flight checks for the pilot positions.

On the EFB, remove the engine covers by using the COVERS option on the Aircraft page.

On the powered flying controls (PFC) section of the left side console, ensure the YAW DAMPERS switch is **OFF**.

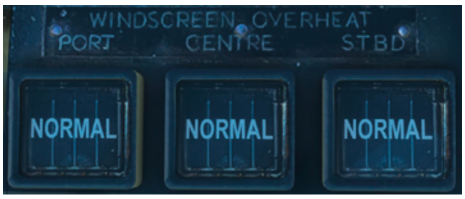
Moving across the top of the PFC panel, check that all PITCH DAMPERS controls are pulled **UP** and all amber lights are illuminated. Check all Mach trimmer controls are also pulled **UP**, with blue light extinguished and amber light illuminated. Then check the three artificial feel controls are pulled **UP** and that the three amber lights are illuminated.

Moving down to the bottom of the PFC panel, press all ten PFC buttons and confirm ten amber lights are illuminated.

At the top of the main instrument panel, confirm both MAIN WARNING lights are illuminated and the three reminder mechanical indicators are showing white.

On the lower aft side of the throttle quadrant, ensure the airbrake switch is in the fully up position, and check the AIR BRAKE mechanical indicator on the main instrument panel is black, confirming that the airbrakes are in the retracted position.

On the co-pilot's main instrument panel, set the DE-ICE switch to **LOW**. Then test the W/SCREEN OVERHEAT amber light and check that all three WINDSCREEN OVERHEAT mechanical indicators are normal on the aft right-side console.



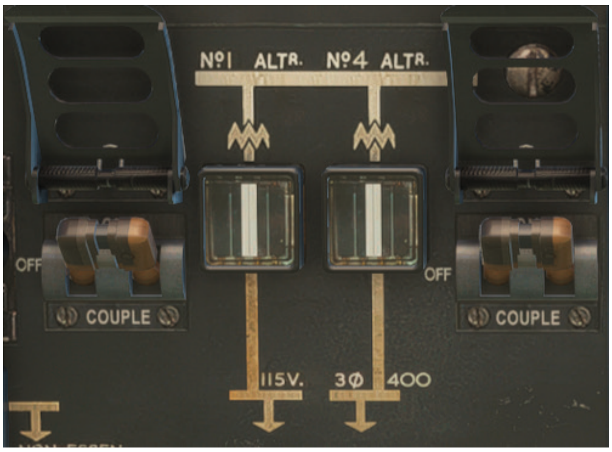
Continuing on the right side console, ensure the A.A.P.P. BLEED FOR CABIN CONDITION switch is set to **SHUT** and that the adjacent mechanical indicator is also indicating SHUT.

At the very aft edge of the right side console, ensure the AVS master switch (labelled VENT SUIT) is in the **CLOSED** position.

The aircraft is now ready to be supplied by 200V power. We can do this in one of two ways: either via the ground power unit or via the AAPP. For this tutorial, although the ground power is already connected, we will also run through the AAPP method.

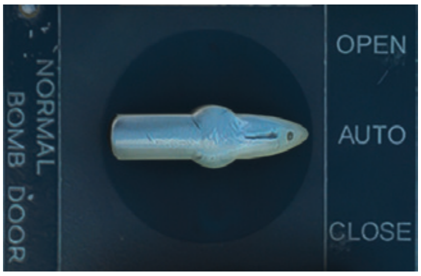
Returning to the AEO position in the rear cockpit, set the AAPP MASTER SWITCH to **ON** and press the AAPP **START** button. The turbine gas temperature (TGT) and oil pressure of the AAPP can be monitored using the gauges on the panel.

Once the TGT has stabilised, press the **AAPP ON** button on the SSP panel to connect the AAPP alternator to the synchronising busbar.



We can then switch **ON** both 115V transformers and confirm that that the two mechanical indicators are showing in-line.

Returning to the front cockpit and to the left side console, turn on the VHF and UHF radios by moving the mode selector switch to the **T/R + G** position.



Ensure the NORMAL BOMB DOOR control switch is in the **AUTO** position, and that the bomb bay doors' position corresponds with the BOMB DOORS mechanical indicator on the main instrument panel.

Moving up to the main instrument panel, set the 1st pilot's altimeter to **RESET** and confirm that the STBY flag clears.

Moving to the underside of the coaming, above the centre instruments, open the four LP fuel cock switch guards and move the switches to the **OPEN** (forward) position.

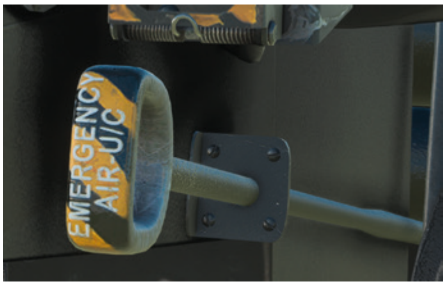
Moving down the panel, reset the accelerometer by pressing the **PUSH TO SET** button.

Confirm that the landing gear is selected **DOWN** and that three green lights are showing on the position indicator.

Confirm that the parking brake is set to **ON**, with the hydraulic pressure indicator indicating that two pressures are in the green band range.

If the pressures are not in the green band range, select the EHPP switch to **START** to increase the pressure, and then return the switch to the central position once the pressures are in the green.

On the left side of the throttle quadrant, ensure the TAKEOFF/CRUISE selector is in the **TAKEOFF** position with the guard closed, and that the JPT LIMITER is in the **ON** position with guard closed.

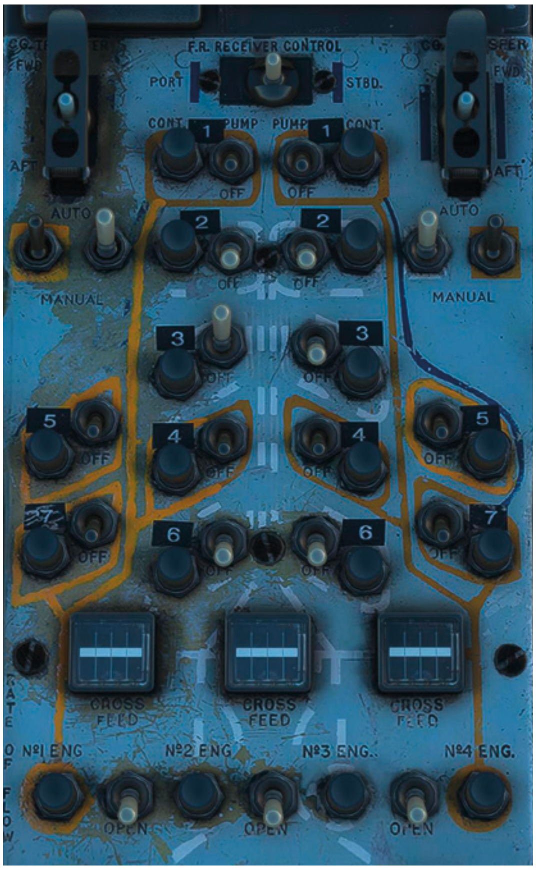


On the right side of the throttle quadrant, ensure the EMERGENCY AIR-U/C lever is fully in.

Ensure the HRS/MFS switch is in the **MFS** position.

On the fuel quantity gauges, ensure we have enough fuel for the flight. For this tutorial flight we will be taking off with the default weight that the aircraft loads in at, which should provide us with approximately 75,000 lb of fuel, which is more than enough for our short flight today.

We can now move down to the fuel console and extend it to its flight position by left-clicking on the handle on the aft side of the unit.



On the fuel panel, we can perform checks of each individual fuel pump by switching **ON** one pump and confirming that the respective FUEL PRESS mechanical indicator on the main instrument panel turns black. Then set the three cross-feed cocks to **OPEN** and confirm that all four FUEL PRESS mechanical indicators on the main instrument panel are black. We can then **CLOSE** the cross-feed cocks and confirm that the four mechanical indicators return to white.

As we do not have fuel tanks fitted in the bomb bay for this flight, we can leave all switches on the bomb bay fuel panel OFF.

We can now power on the autopilot ready for flight.

Confirm that the three channel switches – R (rudder), A (aileron) and E (elevator) – are selected **IN** (up) and then pull the POWER knob. After a short delay the READY magnetic indicator will show white to indicate that the autopilot is powered up and ready for use.

If the POWER knob does not hold in the UP position, and the READY mechanical indicator remains black, the 28V supply to the autopilot will first need to be reset by toggling the RESET switch on the right side console.

On the co-pilot's instrument panel, set the MFS/TFR switch to **MFS** and check that the bomb bay and wing/fuselage fire warning lights are extinguished.

Moving down to the right side console, set the THROTTLE DETENT ISOLATION SWITCH to **OUT**. The throttle detent is a system that features only on aircraft fitted with Olympus 301 engines and causes the inboard engines to have a slightly higher flight idle RPM at higher altitudes compared to the outboard engines.

Set the PRESSURE SELECTOR to the **CRUISE** position and rotate the guard to prevent inadvertent movement of the switch back to the NO PRESSURE (aft) position.

Continuing on the cabin heat and pressure controls panel, set the two CABIN AIR switches to **SHUT**, ensure the ram air valve is **SHUT**, the temperature selector is **COLD** and the cold air turbine mechanical indicator is black.

On the lighting controls section of the right side console, set the EXTERNAL LIGHT master switch to **ON** and set the NAV LIGHT to **FLASH**.

Starting the engines

We are now ready to start the four mighty Bristol Siddeley Olympus 201 turbojets.

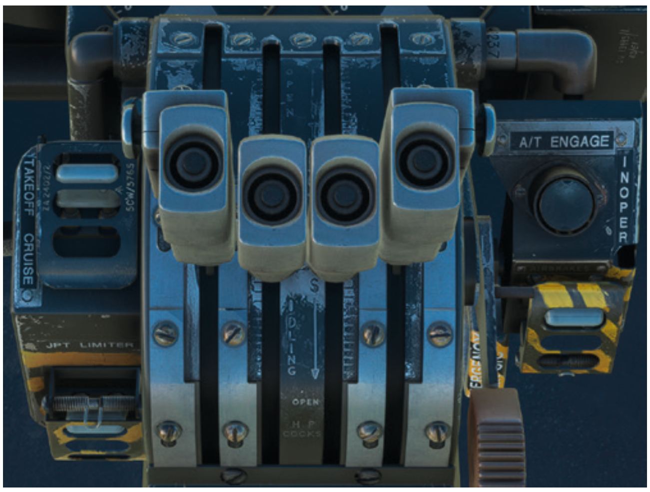
There are two methods that can used for starting the engines: a normal start and a rapid start. The full engine start procedures for each method can be found in the Engine starting system section of this manual. This tutorial will cover engine starting with the rapid start system.

Close the crew entrance door by clicking on the CREW DOOR option on the Aircraft page of the EFB and confirm that the ENTRANCE DOOR UNLOCKED magnetic indicator shows black.

Remove the covers from the engine intakes and exhausts by clicking the COVERS options on the Aircraft page of the EFB.

Check that the area surrounding the aircraft is clear of obstructions and then move the NAV LIGHT switch to **FLASH** to illuminate the beacon lights.

On the centre console, switch **ON** all the fuel tank pumps and confirm that the AUTO/MANUAL switches are set to **AUTO** and the CROSS-FEED switches are set to **CLOSED** (up).



Left-click on the base of all four throttle levers to move them up to the HP COCKS **OPEN/IDLING** position. Advance the throttle levers to approximately 50%.

We can now move over to the engine start panel at the aft end of the left console. The ejector seat armrests can be raised for a clearer view of the consoles by left-clicking on them.

Set the air selector switch to **RAPID** and the ignition and engine master (MSW) switches to **ON**.

We are now ready to initiate the rapid start sequence. Press the **RAPID START** button and confirm that all four engine start lights illuminate.

On the centre instrument panel, monitor the oil pressure, fuel flow, JPT and RPM gauges to confirm that all four engines are spooling up. Ensure the fire warning lights do not illuminate.

Confirmation of four successful engine starts is shown by the four engine start lights extinguishing. Once this occurs, switch **OFF** the ignition and engine master (MSW) switches and bring the throttle levers back to the idle position.

Configuring the aircraft

With the engines started, we can now proceed with the remainder of the after start checks.

Moving to the AEO position in the rear cockpit, switch **ON** the four alternators and confirm that the four amber lights extinguish.

Switch **ON** the two TRUs.

Returning to the front cockpit, we can perform a test of the airbrake emergency and normal motors. Extend and retract the airbrakes and confirm that the mechanical indicator displays the corresponding position.

Using the NORMAL operation selector on the left console, **OPEN** the bomb doors and confirm the magnetic indicator shows cross-hatch while the doors are in motion and then white when they are fully open. Retract the doors by rotating the selector back to **CLOSE**.

On the left console, switch **ON** the PFCs, auto-stabilisers and artificial feel by pressing the PFC START buttons in the order of A-E-R, with a one-second gap between button presses. Confirm that all lights are out, the three reminder mechanical indicators on the main instrument panel are black, the main warning lights are out, and perform a systems check of the flying controls.

Remove the ground equipment by clicking on the GND POWER, PALOUSTE and CHOCKS options on the Aircraft page of the EFB. Briefly change over to the external camera to confirm all equipment has been removed.

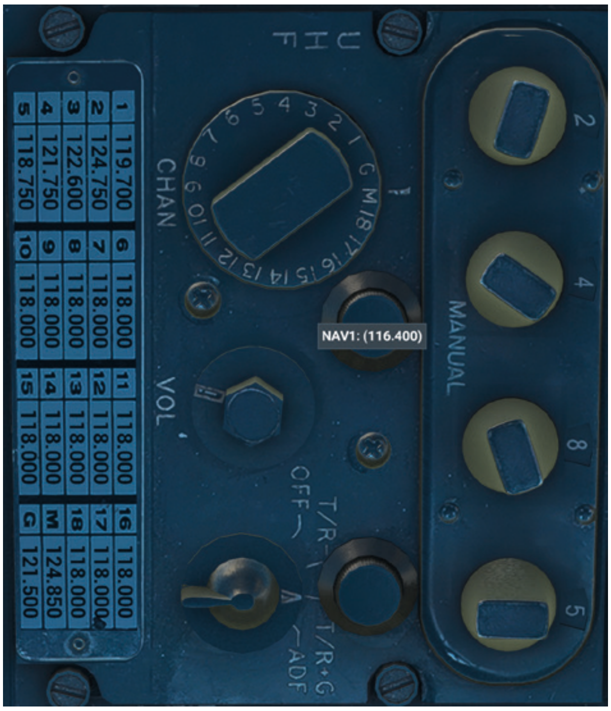
Returning to the alternator control panel in the rear cockpit, connect all alternators to the synchronising busbar, confirm successful load sharing and then isolate alternators 1, 3 and 4, leaving only the No.2 alternator connected to the synchronising busbar.

The Vulcan is a joy to fly by hand under visual flight rules so we won’t be making extensive use of the autopilot on this flight. We will, however, be using various VORs and TACANs en route to keep us clear of any busy airspace.

We can tune the first TACAN station on our route – **WIT (123X)** – on the TACAN radio panel in the rear cockpit. This panel can be accessed in a similar manner to the AEO’s panel, by selecting the NAVIGATOR camera position on the Aircraft page of the EFB.

On the TACAN radio panel, set **123** on the rotary selectors, **X** on the X/Y switch and **T/R** on the mode selector switch.

Once we are airborne and within line of sight of the WIT TACAN station, a bearing and distance to the TACAN station will be displayed on the TACAN indicator in the centre of the main instrument panel.



As we plan ahead, we can also tune the VOR on our flight into the NAV radios. On the two rotary selectors on the left console radio unit, tune in **116.40** and set the mode selector to **T/R + G**.

Note: *We recommended having instrument tooltips enabled in MSFS Options > General Options > Accessibility to see what frequency is being tuned on this panel. Alternatively, a Radio menu is provided on the Aircraft page of the EFB where you can view and adjust the active frequency.*

Once we are within range of the DTY VOR, bearing and distance will be displayed on the beam compass.

Continuing on the left side console, switch **ON** the radio altimeter. Set the RANGE scale to 500 ft and use the TEST switch to confirm that the scale reads between 55 and 75 feet. Once the test is complete, the radio altimeter can be set back to its default 5,000 ft range.

As we prepare to move the aircraft, we can now stow the ejector seat pins by left-clicking on any one of them. They will all be stowed in a holder above the left and right consoles.

On the right console, switch **ON** the pressure head (pitot) heaters and extend the left and right taxi lights (fully down position).

Taxi

We can now taxi to the runway. As the wind is calm, we will be departing from runway 20 and then turning left (south) to approximately 160 degrees to fly towards the WIT TACAN station.

Check that the area around the aircraft is clear of obstacles and then release the parking brake. Apply power slowly to get the aircraft rolling and then start your taxi to the threshold of runway 20.

Steering the aircraft with the rudder pedals only is generally sufficient. Combined use of the rudder pedals and the brakes permits, if necessary, tight turns. Differential engine power can also be used.

As we taxi, check the operation of all gyroscopic instruments by means of alternate turns.

Stop at the holding point just short of runway 20.

Perform a full and free movement check of the flying control surfaces and trims, and confirm that all PFC lights are extinguished.

Set the NAV and pitch selectors to the central position and pull **UP** the TRACK knob on the autopilot panel; this will allow the flight directors to provide guidance to the TACAN station.

On the beam compass, left-click on the heading index knob to push it in and rotate your mouse wheel to align the runway heading (198) with the top datum.

On the AEO's panel, check that all alternators are ON and then connect the AAPP to the synchronising busbar by pressing the AAPP ON button. Confirm that the 115V transformers and 28V TRUs are also ON and that all indications are normal.

We can now work out our rotation and initial climb speeds. Using the Rotation and initial climb speeds table, we can deduce that at our current aircraft weight rounded up to 180,000 lb, we will have a rotation speed today of **148 knots** and an initial climb speed of **156 knots**.

Extend the landing lamps to the **LANDING** position and set the No.1 and No.2 ENGINE AIR switches to **OPEN** and the PORT CABIN AIR switch to **OPEN**.

With the before take-off checks complete, have a look left and right, verify that nothing is on approach and that the runway is clear, and then taxi onto the runway.

Take-off

Line up with the runway centre line and then come to a stop.

With up to 80,000 lb of thrust, the Vulcan gains airspeed and altitude at an extraordinary rate, so it is important to stay ahead of the aircraft during take-off and initial climb. We would recommend reading the Take-off and Climb sections of this tutorial flight before performing them so you have an idea of what to expect.

Holding the aircraft on the brakes, smoothly increase power to 80% RPM. Once all engines stabilise, release the brakes and advance the throttles to full power. As the aircraft starts to gather speed, apply a small amount of nose-down pressure on the control column to keep the nose-wheel in contact with the ground, and use rudder inputs to keep the aircraft on the centreline.

As we pass **148 knots**, pull the control column back to the neutral position and a slight back pressure should

start to raise the nose of the aircraft.

The aircraft will begin to climb away from the runway. Once we are safely airborne, apply the brakes for four seconds before raising the undercarriage.

Make elevator inputs as required to maintain an initial climb speed of approximately **156 knots**, holding the runway heading (198 degrees).

Climb

Once we are in a stable climb, lower the nose and start accelerating to our climb speed of **250 knots**.

Reduce power to less than 90% RPM and then set the TAKEOFF/CRUISE selector to **CRUISE**. Once set, we can then increase power back to **95% RPM**, the maximum permitted RPM for day-to-day operations.

The landing lamps will retract automatically when airspeed exceeds 180 knots, so we can also set both landing light switches to **RETRACT**.

We can now start a left turn towards the RAF Wittering TACAN. The bearing and distance to the TACAN is shown on the TACAN indicator on the centre instrument panel. The TACAN indicator should indicate a bearing of approximately 160 degrees to the WIT TACAN, which we can then compare against our current aircraft heading as indicated by the heading pointer on the beam compass and make any changes in heading as necessary.

As the aircraft approaches **5,000 ft**, level off and throttle back to maintain **250 knots**.

Rotate the Pitch selector to **HEIGHT** and the flight directors will now provide vertical guidance for level flight.

The aircraft is great fun to fly at low level, but at 5,000 ft we have given ourselves some altitude to ease the workload on this first flight and also to stay out of the busy controlled airspace between London and Birmingham.

Rotate the heading index on the beam compass to match your current heading towards the TACAN, as indicated by the heading pointer. The beam bar and flight directors will then provide guidance for maintaining the current bearing for the TACAN.

Cruise

Although we intend this tutorial flight to be hand flown, we will briefly walk though how to engage the autopilot in order to reduce the workload in the cockpit. On the autopilot unit, pull the **ENGAGE** switch, confirm that the IN magnetic indicator is showing white, then pull the **TRACK** switch and rotate the IAS/ALT selector to **ALT** and pull it out.

The autopilot will now hold the selected track (heading) and altitude.

The autopilot can be disengaged at any time by pushing in the ENGAGE switch and confirming that the IN magnetic indicator is showing black.

We can now complete our top of climb checks.

Moving to the AEO's position in the rear cockpit, connect the No.3 alternator to the synchronising busbar before then pressing the EXTRA SUPPLIES TRIP button to disconnect the AAPP and setting the AAPP master switch to **OFF** to shut down the AAPP.

Moving back to the front cockpit, on the right console, move the remaining ENGINE AIR and CABIN AIR switches to the **OPEN** position.

As the former V-Bomber base of RAF Wittering comes into view out of the narrow windscreens, we can start to prepare for our outbound leg from the WIT TACAN to the DTY VOR.

As we already preset the frequency for the DTY VOR (**116.40**) in our pre-flight checks, we can simply rotate the NAV selector to the LOC position and the flight directors and beam compass will start to provide guidance to the VOR based on the course selected on the beam compass.

As we want to fly an inbound course of **221 degrees**, we can rotate the compass scale so that 221 degrees is aligned with the top datum. Once aligned, the flight directors and beam bar will then provide guidance for us to fly inbound to the DTY VOR on a course of 221 degrees.

As we overfly RAF Wittering, as indicated by the TACAN indicator needle swinging around to face aft, begin a right turn and follow the flight director guidance to align the aircraft with the DTY VOR.

During this leg of the flight we will pass over, or close to, the towns of Corby, Kettering and Northampton.

As we have settled into the cruise stage of the flight, this may be a good opportunity to explore the cockpit using the SYSTEMS GUIDE for reference or to practise opening and closing the bomb bay doors.

As we approach the Daventry VOR, as indicated by the DME distance indicator on the 1st pilot's lower instrument panel, we can now set up our radios to intercept the next TACAN on our route: **BZN (56X)**.

Moving to the TACAN radio panel in the rear cockpit, tune in **56X**. On returning to the front cockpit, the TACAN indicator will now be providing course and distance information to the Brize Norton TACAN station.

We will continue to follow our flight director guidance until we have passed overhead the Daventry VOR, as indicated by the DME distance indicator showing 0 NM, and then we can rotate the NAV selector back to the central position and make a left turn to fly our inbound course to the Brize Norton TACAN. Remember to rotate the compass scale on the beam compass to align our inbound course of **215 degrees** with the top datum.

For additional situational awareness, we can also tune into the BZ NDB by rotating the knob on the intercom panel on the co-pilot's lower instrument panel to **386.0**.

The relative bearing to the NDB will then be shown on the ADF indicator on the co-pilot's lower instrument panel.

Although it is not fitted to the real aircraft, we have included a GPS unit which can be used to track your progress and can be enabled on the Aircraft page of the EFB – a useful substitute for the rear crew navigator! The EFB Map app can also be useful for noting which towns and cities we are overflying.

Descent

With an airspeed of 250 knots, it won't take us long to reach RAF Brize Norton. With RAF Fairford's close proximity to the base, we should see our destination come into view as we approach the TACAN station.

Once we are approximately **10 NM** from the BZN TACAN, as indicated by the TACAN indicator, we can perform a few tasks to reduce our workload during the approach.

Set the TAKEOFF/CRUISE selector to **TAKEOFF**.

On the right side console, set the No.3 and No.4 ENGINE AIR switches to **SHUT** and the STARB CABIN AIR switch to **SHUT**.

At the AEO's station, start the AAPP and connect it to the synchronising busbar. Interlocking circuits prevent the AAPP alternator from being connected to the synchroning busbar if number 1, 3 or 4 alternators are already connected. Therefore, to connect the AAPP we first need to isolate the No.3 alternator, which automatically connects the No.2 alternator to the synchronising busbar, and then press the AAPP ON button to connect the AAPP.

We can then set up our instruments for an ILS approach onto runway 27 at RAF Fairford. On the left side console, tune in frequency **111.10**. On the beam compass, rotate the compass scale to align the runway heading of **270 degrees** with the top datum.

Rotate the NAV selector to **GP** and the pitch selector to **APPROACH**. The flight directors will now provide vertical and horizontal guidance for the localiser and glideslope.

Once overhead RAF Brize Norton, we should be able to see RAF Fairford in the distance at our 12 o'clock position. Begin a left turn to a heading of **180 degrees** to bring us onto a base leg for runway 27 and begin a descent to a circuit height of **1,000 ft**.

As we descend, slow the aircraft to our pattern speed of **173 knots**, using **MEDIUM DRAG** airbrakes as necessary, and extend the landing lights.

Approach and landing

With RAF Fairford in view out of the starboard windows, we are now established on the base leg for runway 27.

Extend the landing gear and check for three green lights.

Ensure the parking brake is **OFF** and that brake pressures are in the green band range.

Continue descending and make a right turn from base to final, using the PAPI lights and flight directors to guide our descent rate.

Once established on final for runway 27, begin to reduce airspeed to our approach speed of **158 knots** and, if you have not already done so, extend the airbrakes one notch to the **MEDIUM DRAG** position.

Passing over the runway threshold, extend the airbrakes to **HIGH DRAG** and slow the aircraft to our threshold speed of **143 knots**.

As the aircraft arrives over the runway, start to bring it into a flare, gently raising the nose just above the horizon. Reduce the throttles to idle and the aircraft should touch down smoothly.

Once speed is below **135 knots**, we can deploy the tail parachute by moving the switches on the centre instrument panel to **STRM** (stream) or by using the TOGGLE ARM SPOILERS control assignment.

Apply gentle braking and, once the aircraft has slowed to **60 knots**, jettison the parachute and turn right off the runway onto taxiway A.

Once we are safely off the runway, switch **ON** the taxi lights, retract the airbrakes and begin taxiing to the parking area on the north side of the airfield.

Shutdown

As we taxi, briefly move to the AEO's position in the rear cockpit, connect the No.3 alternator on the sync bar, press the EXTRA SUPPLIES TRIP button and then shut down the AAPP by setting the master switch to **OFF**.

On the centre console, switch **OFF** the autopilot power and set the four AUTO/MANUAL fuel switches to **MANUAL**.

Once we have come to a stop at our chosen parking spot, engage the parking brake.

Set the DE-ICE switch on the co-pilot's instrument panel to **LOW**.

Returning to the front cockpit, switch **OFF** the PFCs, auto-stabilisers and artificial feel, and ensure all lights are illuminated.

We can open the bomb bay doors by moving the bomb door normal control switch to the **OPEN** position.

On the engine start panel, set the engine master switch to **OFF**.

Switch **OFF** all radio equipment.

Retract the taxi lights and switch **OFF** the pressure head heaters.

On the EFB, open the entrance door.

Moving to the AEO's position in the rear cockpit, set both 115V transformers **OFF** and 28V TRUs **OFF**.

Returning to the front cockpit, confirm that the four throttle levers are in the **IDLE** position and then left-click on the base of each of them to **SHUT** the HP cocks.

On the centre fuel console, set the four AUTO/MANUAL switches to **MANUAL** and set all the fuel pumps to **OFF**.

On the right side console, switch **OFF** all external lighting before also switching the master switch to **OFF**.

Moving back to the AEO's position, set all four alternators **OFF**.

On the right side console, ensure all four engine air switches and both cabin air switches are set to **SHUT**.

Set the AVS master switch to **OFF**.

On the EFB, enable the CHOCKS and COVERS item and then set the parking brake to **OFF**.

Finally, returning to the AEO's position in the rear cockpit, switch **OFF** the battery.

Congratulations – you have completed the Vulcan tutorial flight!

VULCAN DISPLAY FLIGHT

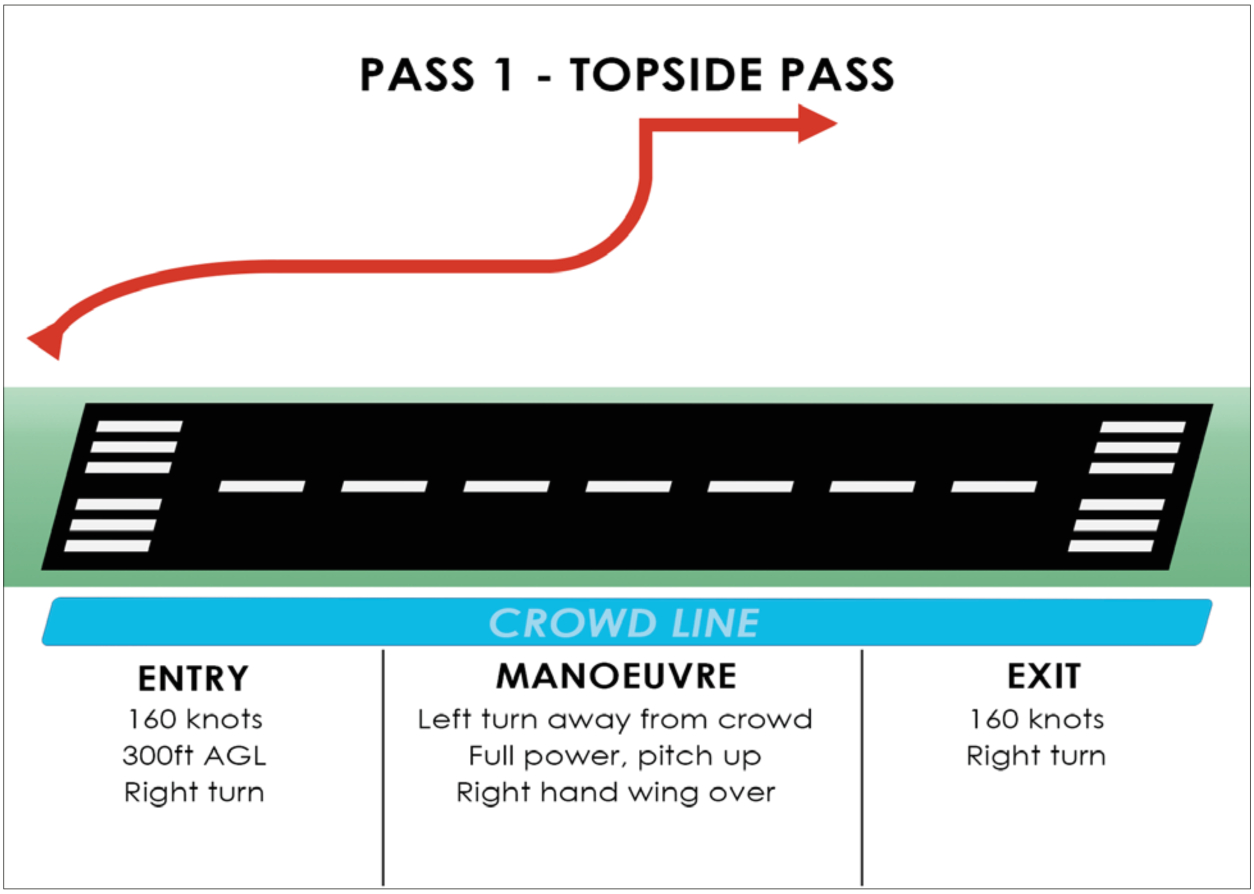
This section covers a typical display routine flown by the RAF Vulcan Display Flight before its withdrawal in 1992, followed by the 2015 Vulcan display in its final season under public ownership.

These examples feature a 'full' display, which would require the cloud base and visibility to be above a pre-agreed limit. If the cloud base and/or visibility would not allow for a 'full' display, a 'flat' display would be performed which would involve the removal of any vertical manoeuvres. The direction of each manoeuvre in the display could also be reversed, depending on the direction of the first pass (either from crowd left or crowd right).

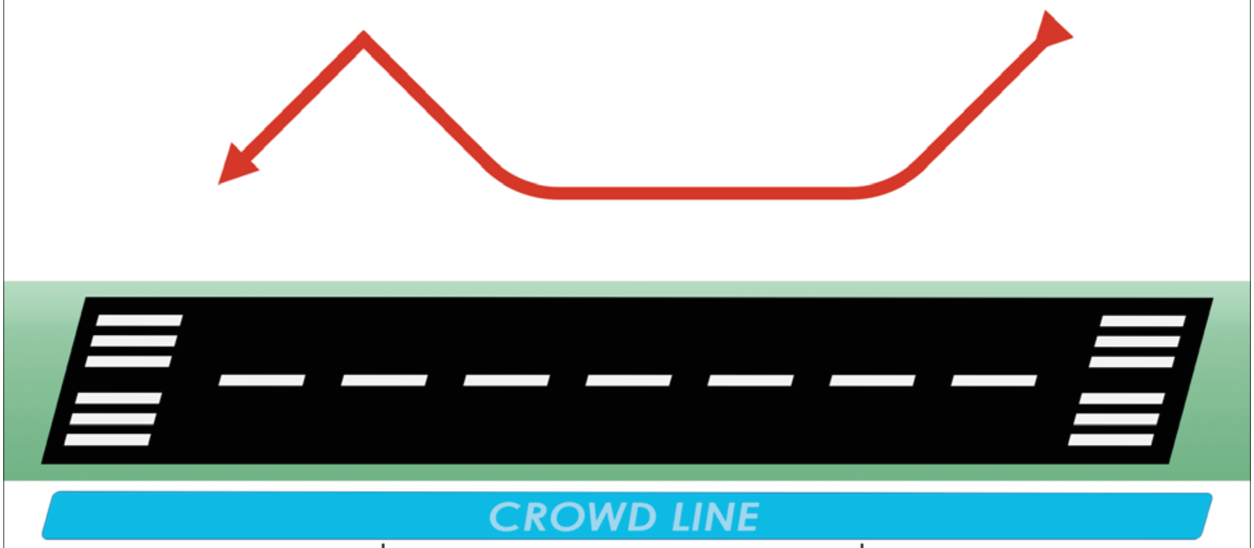
A display would typically begin with approximately 29,000 lb of fuel if the aircraft was taking off and landing at the airfield at which the display is to be performed (total aircraft weight of approximately 130,000 lb). The amount of fuel required would be increased for displays at airfields further afield.

The minimum display height is 300 feet for all manoeuvres unless otherwise stated.

1992 final RAF display season

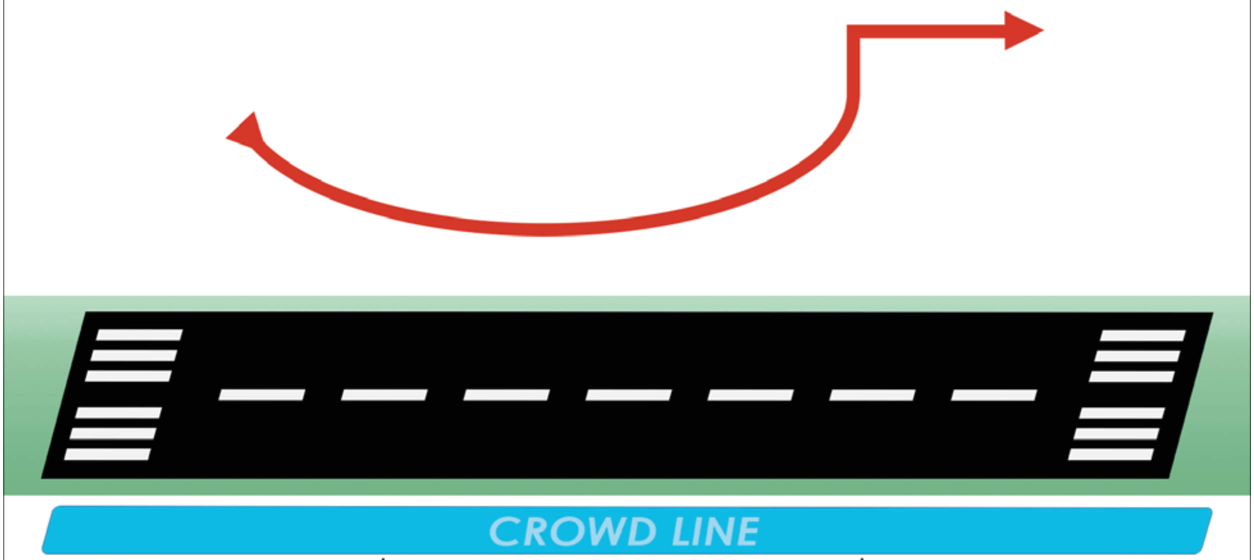


PASS 2 - STRAIGHT AND LEVEL



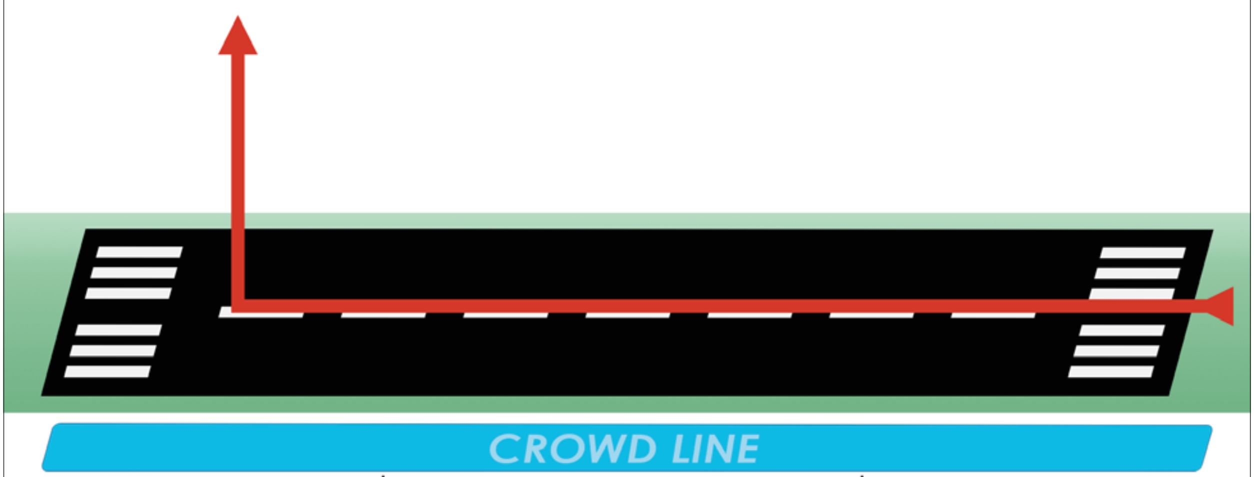
ENTRY	MANOEUVRE	EXIT
160 knots 300ft AGL 45 degree to crowd	Right turn to wings level Right turn to 45 degrees Full power, pitch up Left hand wing over	160 knots Left turn

PASS 3 - UNDERSIDE PASS



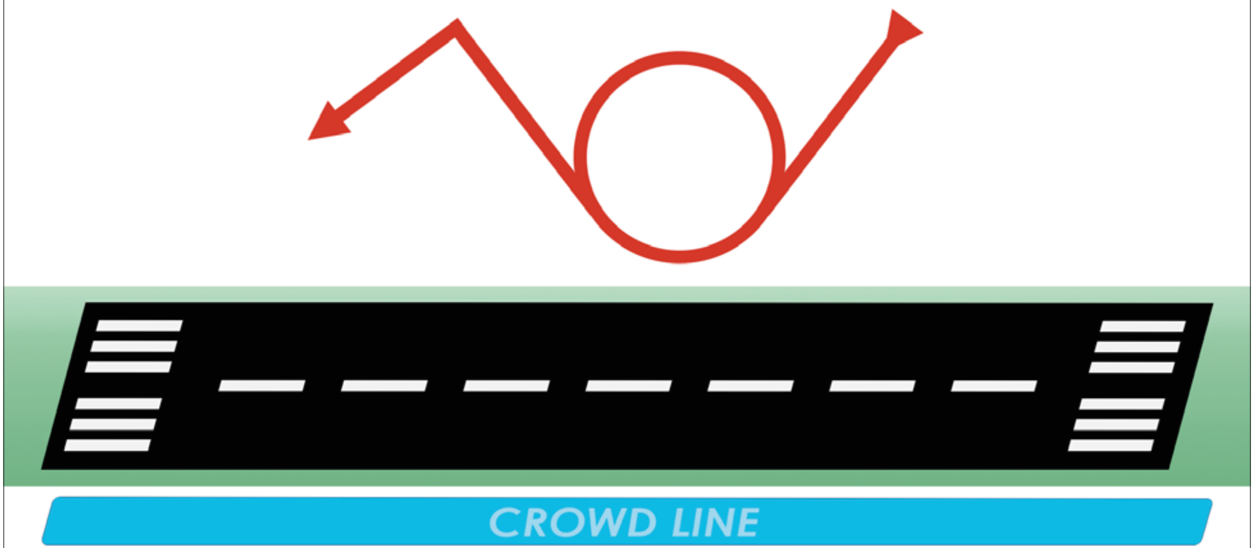
ENTRY	MANOEUVRE	EXIT
160 knots 300ft AGL 45 degree to crowd	Left turn away from crowd Full power, pitch up Right hand wing over	160 knots Right turn Gear down

PASS 4 - TOUCH AND GO

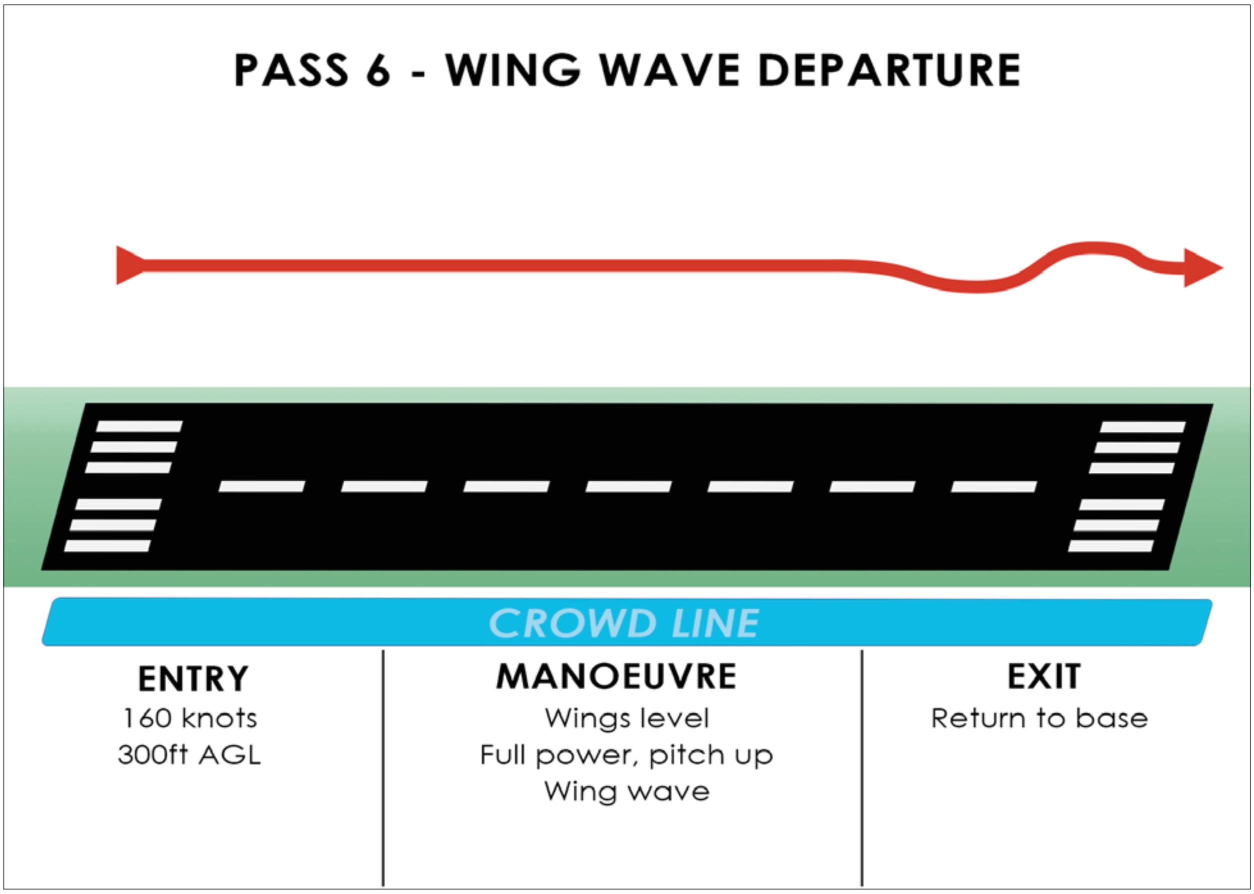


ENTRY	MANOEUVRE	EXIT
Align with runway 130 knots	Main wheels touch down Hold the nose wheel off Full power, take-off, gear up Right hand wing over	Right turn 160 knots

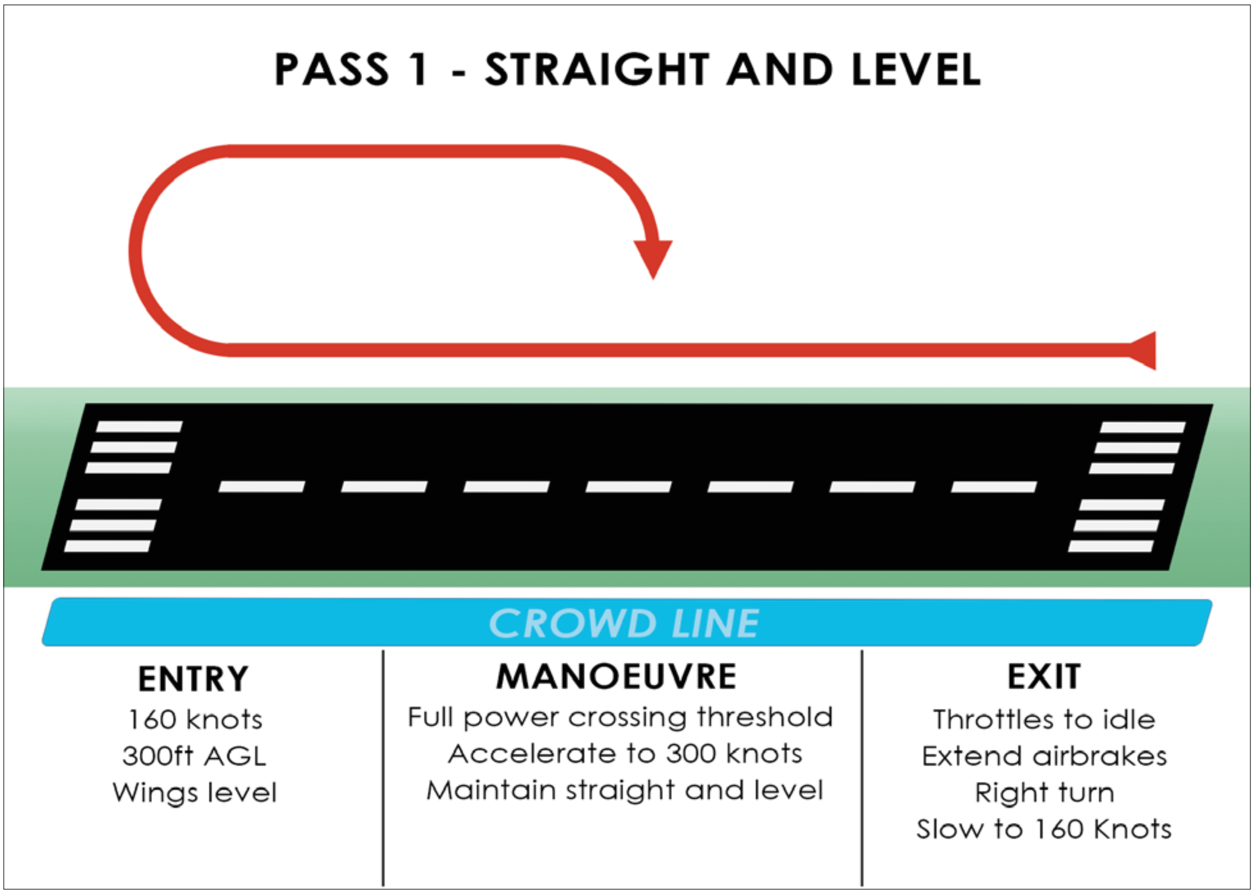
PASS 5 - BOMB BAY OPEN



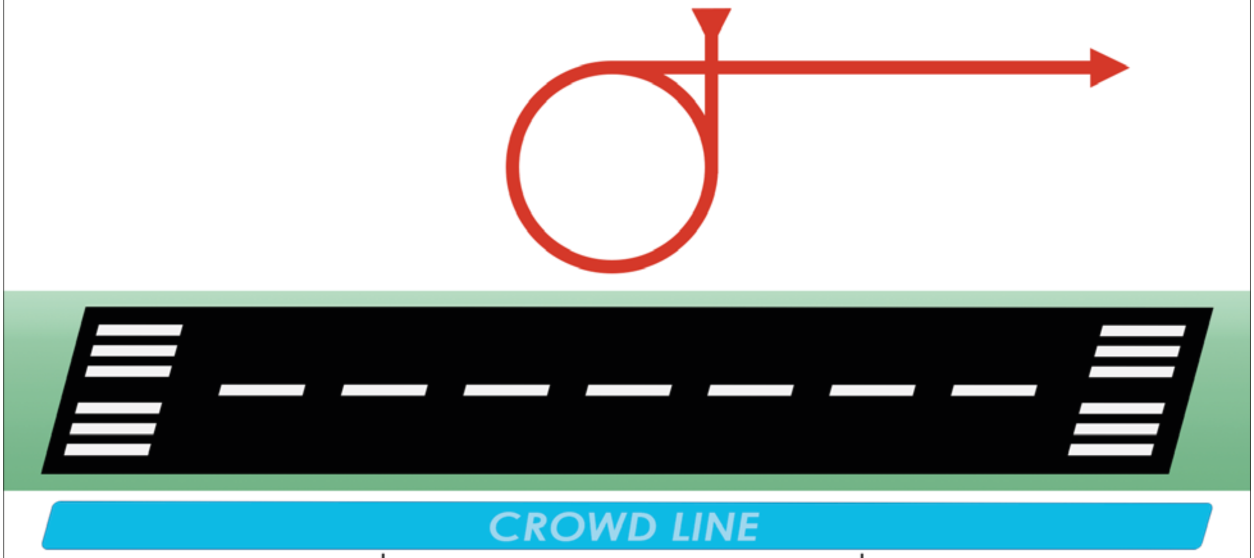
ENTRY	MANOEUVRE	EXIT
160 knots 300ft AGL 45 degrees to crowd	Bomb bay open Right turn, 450 degrees Maintain 160 knots Bomb bay close	45 degrees to crowd Full power Pitch up, left-hand wing over



2015 final public display season

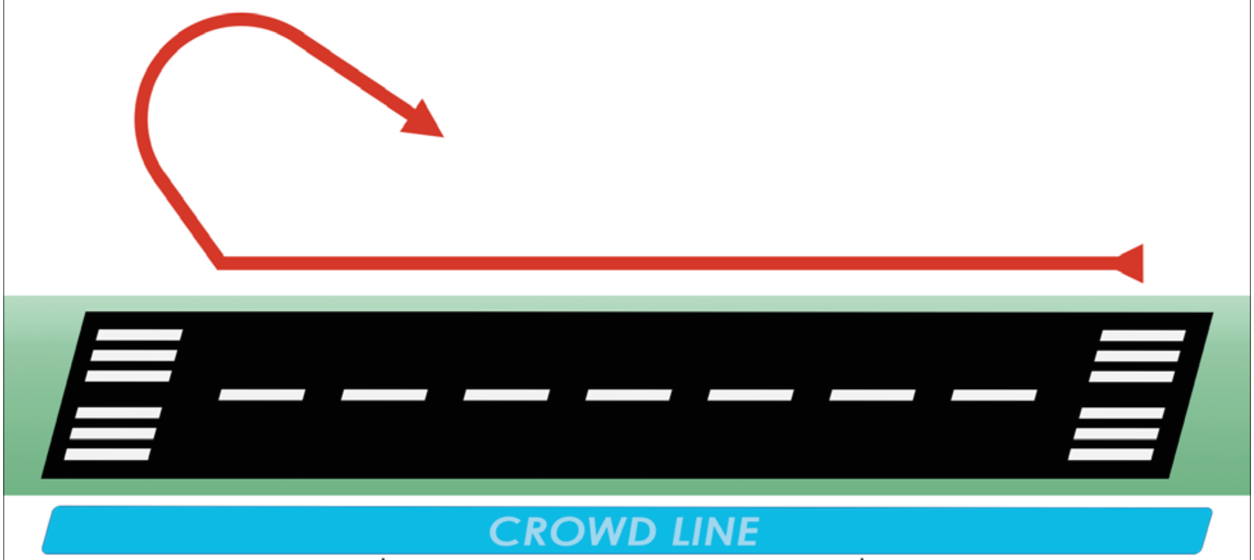


PASS 2 - SPIRAL CLIMB



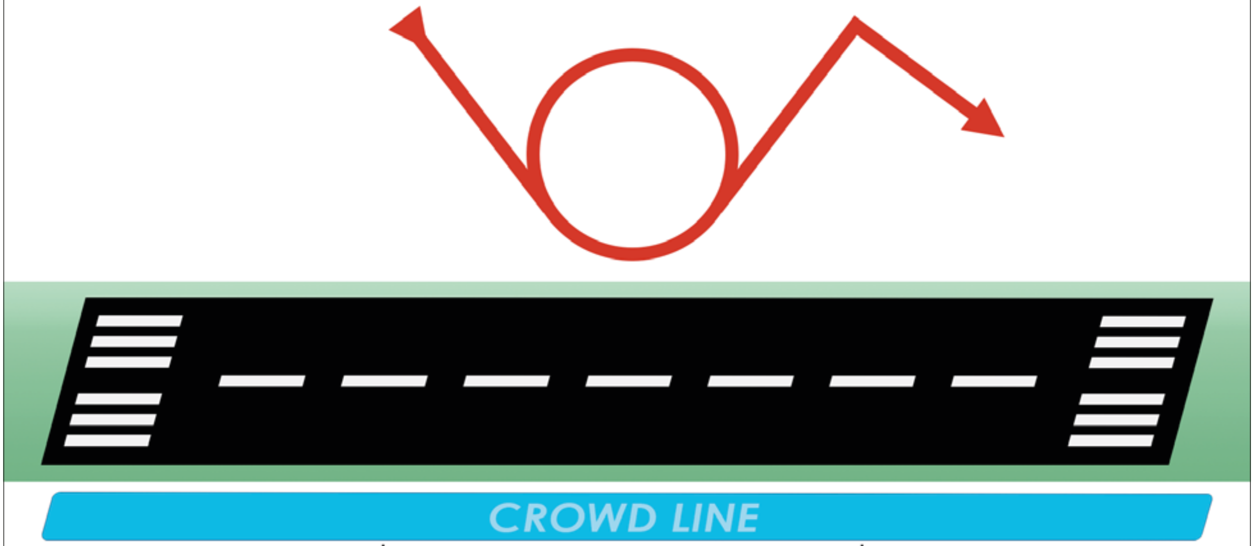
ENTRY	MANOEUVRE	EXIT
Crowd centre 160 knots 300ft AGL	90% RPM Pitch up, right turn 150 knots minimum Complete 630 degree turn	Fly downwind Descend to 300ft AGL Slow to 160 knots Gear down

PASS 3 - GEAR DOWN



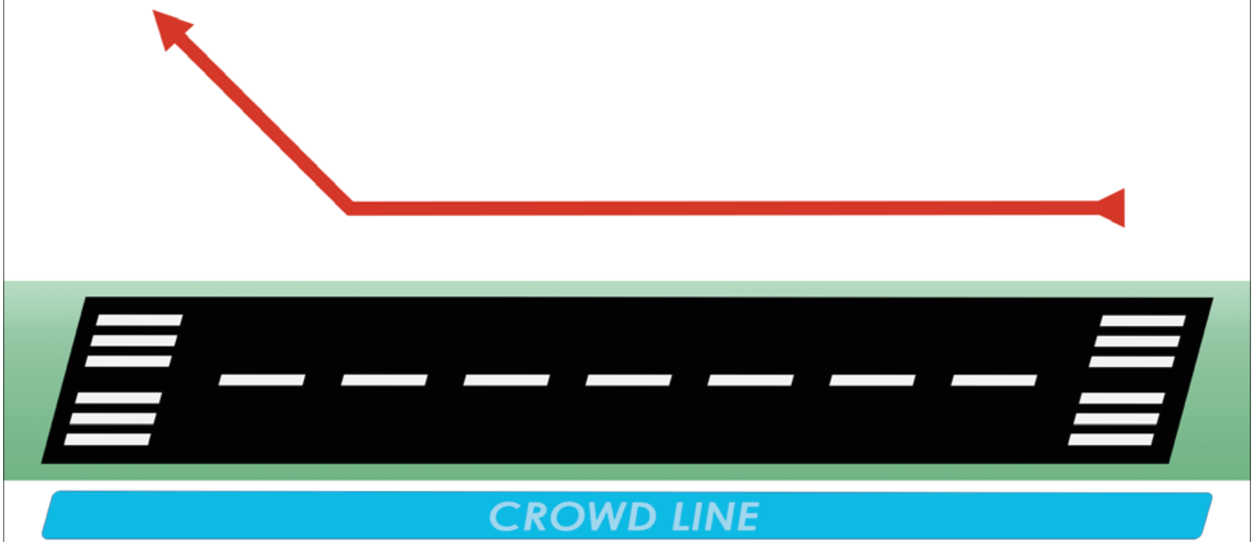
ENTRY	MANOEUVRE	EXIT
160 knots 300ft AGL Gear down	At crowd centre, retract gear 90% RPM Accelerate to 190 KIAS Pitch up, right hand wing over	Throttles to idle Right turn Slow to 160 knots

PASS 4 - BOMB BAY OPEN

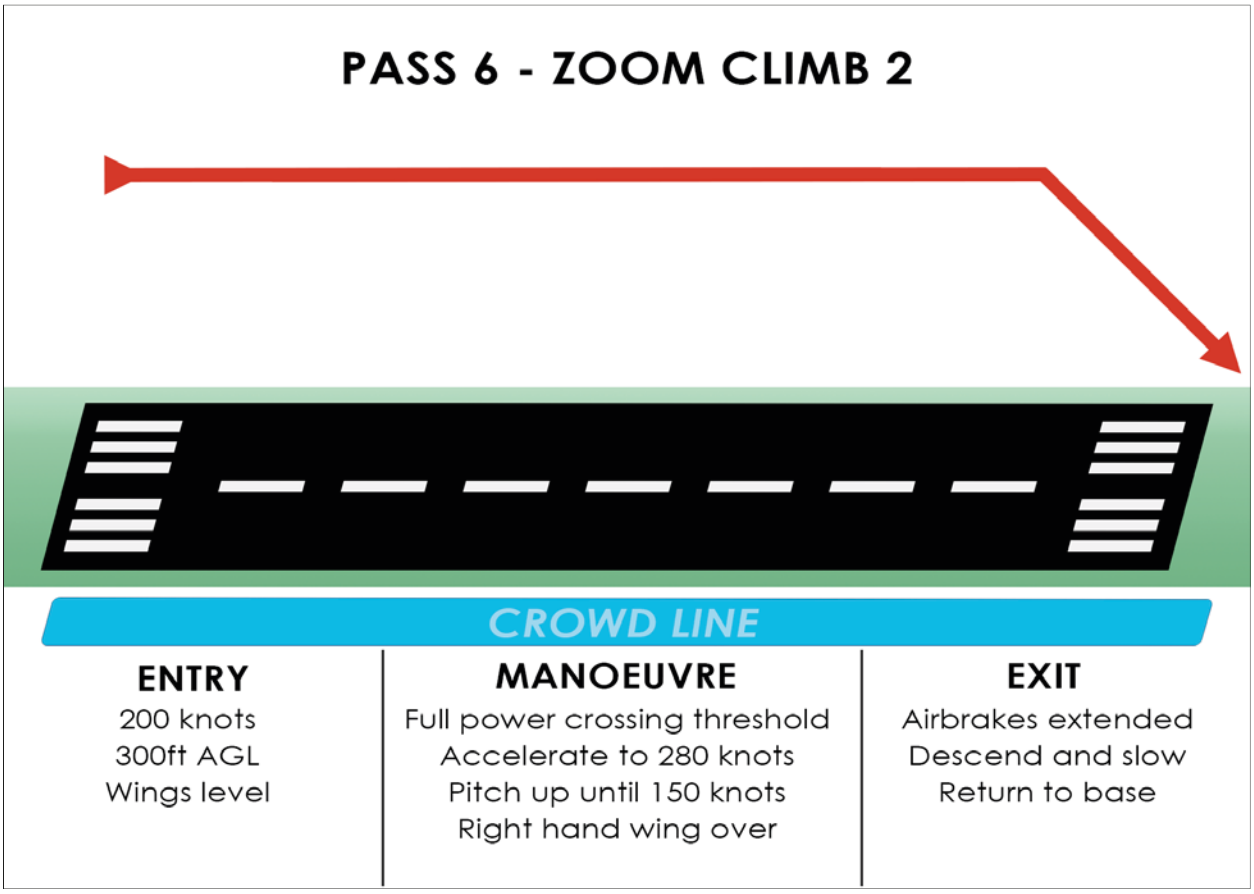


ENTRY	MANOEUVRE	EXIT
160 knots 300ft AGL 45 degrees to crowd	Bomb bay open Left turn, 450 degrees Maintain 160 knots Bomb bay close	45 degrees to crowd 90% RPM Pitch up, right-hand wing over

PASS 5 - ZOOM CLIMB 1



ENTRY	MANOEUVRE	EXIT
160 knots 300ft AGL Wings level	Accelerate to 200 knots 90% RPM Pitch up, right hand wing over	45 degrees to crowd Left turn Maintain 200 KIAS


PASS 6 - ZOOM CLIMB 2
CROWD LINE
ENTRY
200 knots
300ft AGL
Wings level
MANOEUVRE
Full power crossing threshold
Accelerate to 280 knots
Pitch up until 150 knots
Right hand wing over
EXIT
Airbrakes extended
Descend and slow
Return to base

LIMITATIONS

General limitations

G limitations

Up to 160,000 lb	+2G up to M0.89 +1.8G up to M0.93
160,000-190,000 lb	+1.8G up to M0.89 +1.5G up to M0.93
Above 190,000 lb	+1.5G up to M0.93

Weight limitations

Maximum take-off (with ordnance)	210,000 lb
Maximum for normal take-off	204,000 lb
Normal landing	140,000 lb
Overload landing	204,000 lb

Centre of gravity limitations

At weights up to 195,000 lb	142 to 156.9 inches aft of datum
At weights above 195,000 lb	148 to 151.3 inches aft of datum

Height limitations

There are no height restrictions on the aircraft due to airframe limitations. The maximum altitude is limited by the oxygen equipment:

Regulator	Pressure Jerkin	Anti-G Suit	Max. Cabin Altitude (ft)	Remarks
Mk 17F	No	No	50,000	
Mk 21A	Yes	Yes	56,000	Oxygen contents more than 3/8 of total
Mk 21A or B	Yes	No	52,000	
Mk 21 A or B Mk 2 or 2A	No	No	45,000	Above this altitude oxygen pressure is 30mm Hg (max. lungs can stand in comfort)
Mk 3 or 3A	No	No	50,000	
Mk 2 or 2A	Yes	Yes	56,000	

Aircraft approach limitations

The aircraft approach limitations are:

Precision radar	250 feet AGL
ILS, Auto or Manual* (in-line localiser)	250 feet AGL
ILS, Auto or Manual* (offset localiser)	270 feet AGL

**It is advisable that all ILS approaches should be radar-monitored.*

Visual Committal Heights (VCH)

One engine inoperative	150 feet
Two engines inoperative	200 feet

Engine Out Allowance (EOA)

One engine out	0 feet
Two engines out (up to 185,000 lb)	50 feet
Two engines out (above 185,000 lb)	100 feet

Autopilot limitations

Maximum airspeed	350 knots
Maximum Mach number (Mach trimmer operative)	M0.90
Maximum Mach number (Mach trimmer inoperative)	M0.87
Maximum airspeed with TRACK and LOC & GP selected (i.e. feel partially relieved)	180 knots
Minimum altitude (except during ILS approach)	1,500 feet AGL

The artificial feel must be functioning correctly if the autopilot is to be used.

With the autopilot engaged, the following conditions must be observed:

1. Longitudinal trim is to be maintained so that the autopilot trim indicator is within a safe range.
2. One pilot is to be strapped into his seat at all times.
3. The autopilot may be used with the elevator channel disengaged (if operationally essential); in ILS mode the elevator channel must be engaged. Neither the aileron nor the rudder channel may be disengaged separately.

Electrical system limitations

The maximum continuous load per alternator is 32 kW, subject to the maximum continuous CSDU oil temperature of 120°C. This oil temperature must not be exceeded and, if necessary, height or loading must be reduced to keep the oil temperature within limits.

AAPP limitations

Operating altitude	Ground level to 30,000 ft, undercarriage up
	Ground level to 5,000 ft, undercarriage down

There is no guarantee of a successful start above 30,000 ft. The alternator must never be put in load above 30,000 ft.

Maximum loads

Altitude (ft)	Load (kW)	Time (mins)
10,000 to 30,000 undercarriage up	17	30
0 to 10,000 undercarriage up	32	30
0 to 5,000 undercarriage down	23	4
Ground running	32 (up to 45°C OAT)	

The maximum electrical load for AAPP with airbleed is 10 kW.

AAPP JPT limitations

The following maximum JPT limitations apply to flight and ground running under any load:

For maximum of 5 minutes	715°C
For maximum of 1 hour	690°C
Continuous	680°C
During AAPP start	High transient for 10 seconds max.

AAPP oil limitations

The minimum oil pressure is 4 PSI. The pressure varies rapidly with temperature and should not be less than 12 PSI after a cold start.

RAT limitations

Operating altitude	20,000 ft to 60,000 ft
Maximum load	17 kW
Speed range	Maximum speed M0.93 Minimum speed M0.85 / 250 knots (whichever is greater)
Time limit	10 minutes on load above 30,000 ft 10 minutes off load above 50,000 ft

Radio altimeter limitations

The following limitations apply to the Mk 7B radio altimeter:

High range	100 to 5,000 ft
Low range	0 to 500 ft

Air-to-air refuelling limitations

The aircraft is cleared for air-to-air refuelling by day and by night using Victor tankers, and for day-only using Boeing KC-135 Stratotankers with Mk 8 equipment, subject to the following conditions:

The speed of the tanker at and during contact should be:

KC135	260 to 175 knots (at heights up to 30,000 ft)
Victor maximum speed	300 knots up to 31,000 ft M0.80 between 31,000 ft and 35,000 ft
Victor minimum speed	220 knots
Victor maximum altitude	35,000 ft

It is recommended that the airbrakes are set to the MEDIUM drag setting for contact.

The CG control switches may be used to maintain the fuel centre of gravity. Contact must be broken if either needle of the CG indicator goes into the red sector. The A and E tank gauges are monitored during refuelling to ensure that a spurious EMP has not opened the refuelling valves.

Before flights involving night contacts, the probe lighting must be correctly focused on the forward third of the probe.

Bomb bay

The bomb bay fuel tanks may be used in the following configurations:

1. Two cylindrical tanks.
2. One cylindrical tank in the forward position.
3. One A tank in forward position and one cylindrical tank in rear position.
4. One A tank in the forward position of the two forward locations.
5. One A tank forward and one E tank aft.

750 lb and 4,000 lb panniers may be carried with bomb bay fuel tanks to the following configurations:

Forward	Centre	Aft
Cylindrical Tank	750 lb Pannier	Cylindrical Tank
A Tank	750 lb Pannier	
4,000 lb Pannier		
4,000 lb Pannier		750 lb Pannier
Cylindrical Tank	4,000 lb Pannier	
A Tank	4,000 lb Pannier	

If fuel tanks are fitted in the bomb bay, the bomb doors may be opened in flight:

1. When the tanks have been emptied of all usable fuel.
2. During an operational emergency with fuel in the tanks.
3. Provided no panniers are fitted in the bomb bay.
4. Provided that time with the bomb doors open is kept to a minimum.

Speed limitations

Speed and Mach number limitations

With all PFC functional and all auto-stabilisers operative: Maximum speed above 15,000 ft: 330 knots or M0.93, whichever is less.

In wartime conditions a maximum speed of 375 knots is permitted at lower level with a bomb bay load of 16,000 lb.

With one or more PFC inoperative: Maximum speed M0.90.

With one or both servos of the Mach trimmer inoperative: Maximum speed M0.90 unless specifically authorised, then M0.93.

With one pitch damper inoperative: Maximum speed M0.93.

With two or more pitch dampers inoperative: Maximum speed M0.90.

Maximum speeds for operation of services

Airbrakes	No restriction
Bomb doors	Up to normal limiting speed of aircraft
Undercarriage	270 KIAS (M0.9 above 40,000 ft)
RAT	330 KIAS or M0.92
Tail parachute	145 KIAS (jettison at 60 KIAS)
Maximum demonstrated crosswind	20 KIAS

Rotation and initial climb speeds

AUW (lb)	Rotation speed (KIAS)	Initial climb speed (KIAS)
150,000 lb and below	135	148
160,000 lb	139	148
165,000 lb	141	149
170,000 lb	143	151
180,000 lb	148	156
190,000 lb	153	160
195,000 lb	155	163
200,000 lb	157	165
210,000 lb	162	169

Recommended climb speed

250 KIAS to 20,000 ft.

300 KIAS up to M0.86.

Circuit speeds

AUW (lb)	Pattern speed (KIAS)	Approach speed (KIAS)	Threshold speed (KIAS)
120,000 lb and below	155	135	125
130,000 lb	160	140	130
140,000 lb	165	145	135
150,000 lb	169	149	139
160,000 lb	173	158	143
170,000 lb	177	162	147
180,000 lb	181	166	151
190,000 lb	185	170	155
200,000 lb	189	174	159
210,000 lb	193	178	163

Engine limitations

Engine RPM take-off limitations

Olympus 201 Engines		Olympus 301 Engines	
Ambient Temp (0°C)	% RPM Limit	Ambient Temp (0°C)	% RPM Limit
-10	99	-5 and below	102
-5	98.5	0	101.5
0	98	5	101
5	97.5	10	101
10	97.5	15	100.5
15	97	20	100
20	96.5	25	99.5
25	96.5	30	99.5
30	96	35	99
35	96	40	98.5
40	95.5	45	98
45	95.5		

Engine RPM idling speeds

Condition	% RPM	
	Olympus 200 Engines	Olympus 301 Engines
Static sea level idling	32 no load	27 no load
(ISA)	29.5 full load on alternators	24.5 full load on alternators
Approach idling	37 to 41	31 to 35
Idling at 50,000 ft (M0.86)	76 to 78	78 to 81
Windmilling at M0.88	15 to 20	16 to 19

Engine RPM and JPT limitations

The following table shows limitations for Olympus Mk 200 and Mk 301 Series engines. Limitations for the Mk 301 engines are shown in brackets where different.

Condition	Time Limit	Engine Speed % RPM	Max JPT (0°C)
Maximum for take-off and operational necessity	10 mins	101 (100)	670 (625)
Maximum continuous	Unlimited	97.5	610 (570)
Ground idling minimum (alternator on load)	Unlimited	29.5 (24.5) (minimum ISA, SL)	610 (570)
Overspeed	20 secs	104 (107)	
During start			700

Relighting should not normally be attempted above 35,000 ft.

To avoid resonant frequencies which could affect engine fatigue life, the RPM band 95% +/- 1.5% is to be avoided up to 30,000 ft. Furthermore, on the Mk 301 engines, the RPM band 78% to 85% is also to be avoided below 5,000 ft.

Oil system limitations

Mk 200 Series engines

Normal at 90% RPM and above	55 to 60 PSI
Minimum at 90% RPM and above:	
Sea level to 20,000 ft	50 PSI
Above 20,000 ft	45 PSI
Maximum consumption rate	1.5 pt/hr
Minimum oil temperature for starting	minus 26°C

Mk 301 Series engines

Normal at 90% RPM and above	55 to 65 PSI
Minimum at 90% RPM and above:	
Sea level to 20,000 ft	50 PSI
Above 20,000 ft	45 PSI
Maximum consumption rate	1.5 pt/hr
Minimum oil temperature for starting	minus 26°C

CHECKLISTS

Internal checks

AAPP scoop	**OPEN**
Electrical power	**OFF**
Ejector seat pins	**Fitted**
Oxygen	**ON**
Battery	**ON, checked**
Non-essentials trip/reset	**TRIP, check MI (x2)** **RESET, check MI (x2)**
External 28V	**ON**
Nose-wheel steering override switch	**Normal**
Airbrake emergency isolate switch	**NORMAL**
Alternators	**Four OFF, four ambers**
RAT field switch	**Normal, guarded**
AAPP	**LP cock open** **Fire warning test** **Oxygen switch OFF** **Fuel HIGH** **Master switch OFF**
PFC, auto-stabilisers and feel	**All OFF, lights on** **Yaw dampers off** **Pitch dampers off, four amber lights** **Mach trimmers off, blue lights off, amber lights on**
Main warning lights	**Both ON**
Reminder MI	**Three white**
Bomb release safety lock	**LOCK / guarded / green light**
Bomb doors emergency switch	**NORMAL, guarded**
AAPP bleed switch	**SHUT/indicating**
TFR supply switch	**OFF**
Director horizons	**Attitude failure flags**
Airbrakes switch	**Corresponds**
De-ice switch	**LOW, checked**
AAPP bleed switch	**SHUT/indicating**
AVS master switch	**CLOSED**
200V supply	**External ON or start AAPP**
115V transformers	**ON, check MI (x2)** **Check auto coupling** **Check manual coupling** **ON, check MI (x2)**

ILS	**ON, checked**
VHF and UHF	**Checked**
Bomb door normal control	**Corresponds**
Emergency bomb jettison switch	**Central, guarded**
Alt 7B check	**All indicators checked, power OFF**
Compasses	**Synchronised**
Altimeter	**RESET**
Port beam compass	**Checked**
Standby artificial horizon	**Erect, button out**
TFR lights	**Checked**
LP fuel cocks	**OPEN, guarded**
Alternator failure warning	**Flashing**
Canopy unlock MI	**Black**
Entrance door MI	**White**
Pressure head MI	**White**
Accelerometer	**Reset**
Undercarriage	**Checked** **Emergency override horizontal** **DOWN button in** **Six green lights** **D/N screens checked**
Brakes / accumulator pressure	**Parking brake ON, two in the green** **EHPP select START** **Two in the green** **EHPP select STOP/centre**
Anti-dazzle lighting	**Checked**
Take-off/cruise selector	**As required**
JPT limiters	**ON, guarded**
HP cocks	**SHUT**
U/C emergency selector	**Fully in**
MFS/HRS switch	**MFS**
Fuel contents/CG	**Checked**
Fuel console	**Pumps checked individually** **One pump on, cross-feed cocks open, four MI black** **Cross-feed cocks closed, all pumps off, four MI white** **Wing cross-feed cocks open, bomb bay pumps checked individually, all MI black** **Bomb bay pumps off, wing cross-feed cocks closed** **One main pump on per group, four MI black** **MAIN selected** **Transfer switch centre, guarded**
Autopilot	**Power ON, three channels IN** **Reset switch to RESET**

MFS/TFR switch	**MFS**
Bomb bay wing/fuselage fire warning lights	**Checked**
Throttle detent isolation switch	**IN**
Pressure selector	**CRUISE**
Cabin air switches	**SHUT**
Ram air valve	**SHUT**
Temperature selector	**COLD**
Cold air turbine MI	**Black**
External lights master switch	**ON**
Navigation lights	**FLASH**
Tank pressurisation	**OFF, four white MIs**
Air-to-air refuelling panel	**All OFF**
Engine/airframe anti-icing	**OFF**
Systems check (if 200V external supply on)	**Controls, trims, MFS, autopilot checks** **BNS checks** **HF, ECM, IFF checked**

Engine starting

The air for engine starting can be supplied by an external source (the Palouste), by cross-bleed from a running engine or by the rapid start air system.

When using the Palouste, the engines can be started in any order. If cross-bleed is going to be used, engine No.1 or No.4 must be started first.

The three remaining engines can be started individually in the same manner, using the external supply, or the external supply can be removed and cross-bleed used. The running engine must be set to 70% RPM to provide enough cross-bleed air to start the remaining engines.

If the first engine started is No.1 or No.4, the three remaining engines can be started simultaneously using cross-bleed with the running engine set to 90% RPM.

To use cross-bleed, the engine air switches for the running engine and the engine to be started must both be set to OPEN.

Once two engines are running, the remaining two may be started with the two running engines set to 60% RPM.

If the rapid start air system is going to be used, all engines can be started simultaneously using the rapid start button, or the engines can be started individually using the individual start buttons.

Rapid start

Clearance to start	**Obtained**
Throttles	**Set to 50%**
Air selector switch	**RAPID**
Ignition switch	**ON**
Engine master switch	**ON**
Engine air switches	**All SHUT**
Rapid start button	**Press**

Normal start

Clearance to start	**Obtained**
Air selector switch	**NORMAL**
Ignition switch	**ON**
Engine master switch	**ON**
Air cross-feed MI	**OPEN**
Engine RPM	**70%**
Or Palouste	**Connected, ready**
Appropriate engine air switch(es)	**OPEN, remainder SHUT**
Individual start button	**Press**
Throttle	**Idling**

Checks during engine starting

Oil pressure	**Rising**
Fuel flow	**Checked**
JPT	**Less than 700°C**
Fire warnings	**Out**
Start indicator light	**Out above 22% RPM**

After start checks

Alternators	**Four switches ON** **Amber lights out** **S breaker MI horizontal** **KW/KVAR meters reading** **Alternator failure warning light out**
Engine master switch	**OFF**
Ignition switch	**OFF**
Air cross-feed MI	**SHUT**
Fuel console	**As required**
Engine air switches	**All SHUT**
Cabin air switches	**Both SHUT**
Engine anti-icing	**Checked (301), set as required**
Airbrakes	**Test then IN, black MI**
Hydraulic pressure	**Checked, normal**
Bomb door normal operation	**Check clear** **Select OPEN, MI white** **Select CLOSE, MI black**

PFC, auto-stabilisers and feel	**All ON, lights out** **Auto-stabilisers, yaw dampers, pitch dampers and Mach trimmers all on** **Blue and amber lights off** **Artificial feel amber lights out**
Feel lock switch	**NORMAL, green light out**
Reminder MI (three)	**Black**
Main warning lights	**OFF**
Frequency changers	**Checked, No.2 ON**
Systems checks	**Complete**
External 28V	**OFF**
28V TRU (two)	**ON, checked**
AAPP (if not running)	**Master switch ON – scoop open** **Press start button (3 seconds)** **JPT/oil pressure within limits** **Fire warning light out**
AAPP	**On sync bar, within limits** **AAPP ON button pressed** **Check indications**
Extra supplies trip	**Press, No.2 alternator on sync bar**
External power	**Removed**
Alternators	**Synchronise all alternators** **Check load sharing** **Isolate Nos.1, 3 and 4**
AAPP	**On sync bar, within limits** **AAPP ON button pressed** **Check indications**
AVS master switch	**OPEN, checked, set as required**

Taxi checks

Ejector seat pins	**Removed**
Pressure head heaters	**ON**
Entrance door	**Closed, MI black**
Chocks, ground equipment	**Removed**
R/T clearance	**Obtained**
Landing lamps	**As required**
Brakes and nose-wheel steering	**Check**
Hydraulic pressures	**Check, in the green**
Instruments	**Functioning correctly**

System checks

PFCs	**Checked**
Emergency trims	**Check full range**
MFS (co-pilot)	**Check**
Normal trims	**Checked**
Feel relief	**Checked**
Instrument flags	**Clear**
NAV selector	**Central**
Autopilot	**Ready, MI white**

Before take-off checks

Electrics	**Alternators all ON** **AAPP on sync bar** **115V transformers ON** **28V TRUs ON** **Indications normal**
PFC/stab aids panel	**All lights off**
All red and amber lights	**Out**
Magnetic indicators	**All black**
Hydraulic pressures	**Check, two in the green**
Transfer switches	**AFT selected, lights ON**
Fuel console	**AUTO/MANUAL switches to AUTO** **14 booster pumps ON** **Cross-feed cocks SHUT** **BOMB-BAY/MAIN to MAIN**
Transfer switches	**CENTRE/GUARDED, lights off**
De-ice switch	**MEDIUM**
Tank pressurisation switch	**ON**
Altimeters	**All set and checked**
Take-off data	**Checked**
Flying controls	**Checked, full and free movement**
Cabin air switches	**Port or starboard OPEN**
Engine air switches	**1 and 2, or 3 and 4 OPEN**

After take-off / overshoot checks

Undercarriage	**UP, lights out**
Take-off/cruise selector	**CRUISE**
Landing lamps	**Retracted**
Tank pressurisation	**MIs black (x4)**

Cabin air switches	**Port or starboard OPEN**
Engine air switches	**1 and 2, or 3 and 4 OPEN**
Engine/airframe anti-icing	**As required**
Bomb bay tanks	**As required**
ILS	**OFF**

Climb checks

For flights below 20,000 feet

Electrics	**Press extra supplies trip Check No.2 on sync busbar Sync No.4 with No.2 Isolate No.2 AAPP master switch OFF**

For flights above 20,000 feet

Oxygen	**All crew check**
Altimeters	**1013 MB set**
Electrics	**Press extra supplies trip Check No.2 on sync busbar Sync No.4 with No.2 Isolate No.2 AAPP master switch OFF**

Top of climb checks

Oxygen	**All crew check**
De-ice switch	**MEDIUM**
Engine air switches	**All OPEN**
Cabin air switches	**Both OPEN**
Airframe anti-icing	**As required**
Electrics	**Checked**

Low level checks

Pre-descent checks

Route weather	**Checked**
Altimeters	**Subscales set**
Safety altitude and minimum FL	**Checked**
Alt 7B	**ON, 5,000 feet range, 2,000 feet height**
TFR supply switch	**ON, MI standby, 1,000 feet height Selected**

Fuel and CG	**Checked**
Engine air switches	**1 and 2, or 3 and 4 SHUT**
Cabin air switches	**Port or starboard SHUT**
Alternators	**No.3 alternator on sync busbar**

TFR checks (not above 12,000 feet)

TFR control switch	**ON**
TFR/MFS switch	**TFR**
Fail/Safe switch	**Checked**
TFR/MFS switch	**As required**

Initial checks (2,000 feet AGL)

TFR/MFS switch	**As required**
Altimeters	**Set and compared**
Engine/airframe anti-icing	**As required**
Start descent to route height	**Check and compare TFR demands at 1,000 feet AGL**
TFR height selector	**Set route height**
Alt 7B limit selector	**Set route height. Select 500 feet range only when below 500 feet,**

TFR failure procedures (fail lights ON)

Level wings, initiate climb	**. . .**
Fail/safe switch	**RESET**
TFR go lights on	**Cancel ADD monitor if applicable, resume TFR flight**
If fault remains	**. . .**
TFR/MFS switch	**MFS**
TFR control switch	**STANDBY**
TFR supply switch	**OFF**

Low level climb-out checks

TFR/MFS switch	**MFS**
Engine/airframe anti-icing	**As required**
TFR control switch	**STANDBY**
TFR supply switch	**OFF**
Rad alt 7B	**OFF**

Airfield recovery checks

Airfield weather	**Checked**
Safety altitude	**Checked**
Altimeters	**Subscales set**
Fuel / CG / circuit speeds	**Checked**
Take-off/cruise selector	**As required**
Engine air switches	**1 and 2, or 3 and 4 SHUT**
Cabin air switches	**Port or starboard SHUT**
Engine/airframe anti-icing	**As required**
ILS	**On, coding checked**
Alternators	**Sync No.3 with No.4 alternator** **Isolate No.4**

Below 5,000 feet

AAPP	**Start electrically and connect to sync bar**

When required

MFS/HRS switch	**MFS**
MFS NAV selector switch	**Central, re-align heading**

Before landing checks

Undercarriage	**DOWN, three green lights**
Brakes	**Parking brake off, pressures in green**
Fuel	**Contents checked** **AUTO/MANUAL switches to AUTO** **All pumps ON except empty tanks**
Landing lamps	**As required**
Engine air switches	**All SHUT**

After landing checks

Brake parachute	**Jettisoned**
Airframe anti-icing	**OFF**
Engine anti-icing	**As required**
Engine air switches	**All SHUT**
Parking brake	**As required**
Tank pressurisation switch	**OFF**
De-ice switch	**LOW**

No.3 alternator	**On sync busbar**
AAPP	**Checked, OFF**
PFC and auto-stabilisers	**OFF except aux rudder**
Airbrakes	**IN**
Auto/manual switches	**Four to MANUAL**
Autopilot	**Power OFF**
Radio altimeter	**OFF**
Alternators	**No.1 and No.4 OFF, check flashing light**
HP cocks	**No.1 and No.4 SHUT**
Fuel pumps	**One on per running engine**
ILS and ration heater	**OFF**
Hydraulic and brake pressure	**Checked, two in the green**
Ejector seat pins	**Fitted**

Shutdown checks

Parking brake	**ON**
Auxiliary rudder	**Stop, all PFC lights on**
Bomb doors	**As required**
Engine master switch	**OFF**
Landing lamps	**Retracted**
De-ice switch	**OFF**
Entrance door	**Open**
Compass switches	**OFF**
115V transformers	**OFF**
28V TRU	**Both OFF**
HP cocks	**SHUT**
Fuel pumps	**All OFF**
External lighting	**All OFF, master OFF**
Alternators	**All OFF**
Pressure head heaters	**OFF**
Engine air switches	**All SHUT**
Cabin air switches	**Both SHUT**
Engine anti-icing	**OFF**
Aux AVS and face blower master switches	**OFF**
AVS master switch	**CLOSED. Individual controls to be manual and minimum.**
Chocks	**In position**
Parking brake	**OFF**
Battery	**Volts normal, OFF**

MSFS CONTROL ASSIGNMENTS

Microsoft Flight Simulator allows users to customise the controller scheme of their external hardware, which can allow for a much more immersive experience. You can set up these controls within MSFS by navigating to Options > Controls Options.

The following table shows a list of non-normal MSFS control assignments that can be used in conjunction with this Just Flight MSFS Vulcan software:

Aircraft control	**MSFS control assignment**
Airbrakes (RETRACT/MEDIUM/HIGH)	TOGGLE SPOILERS SPOILERS AXIS
Autopilot engage/disengage (aft centre console)	TOGGLE AUTOPILOT MASTER
Autopilot pitch selector (fuel console)	INCREASE AP PITCH HOLD REFERENCE DECREASE AP PITCH HOLD REFERENCE
Bomb bay doors (OPEN/CLOSE)	TOGGLE TAIL HOOK HANDLE SET TAIL HOOK HANDLE
Braking parachute (STREAM/JETTISON)	TOGGLE ARM SPOILERS
HP fuel valves (OPEN/SHUT)	SET ENGINE 1 FUEL VALVE SET ENGINE 2 FUEL VALVE SET ENGINE 3 FUEL VALVE SET ENGINE 4 FUEL VALVE
Next cockpit camera	TOGGLE WING FOLD
Nose-wheel steering toggle button	TOGGLE ANTI-SKID BRAKES
Previous cockpit camera	TOGGLE WATER BALLAST VALVE

Note: *This is not a complete list of all MSFS control assignments for the Avro Vulcan B Mk.2, K.2 & MRR and it does not include the basic control assignments for controls such as Pitch, Roll, Yaw, Throttles etc. which are shared between all aircraft.*

LVARs

Home cockpit users who require the use of LVARs to set up external hardware can find a complete list of LVARs used in the simulator by enabling Developer mode and then, on the menu bar at the top of the screen, navigating to Windows > Behaviours > Local Variables.

Entering instrument names or abbreviations into the ‘Filter’ box will vastly speed up the process of finding LVARs. For example, if you are trying to find the LVARs used for the NAV lights switch, you can search for ‘NAV’ and you will find the following LVAR: **STBD_CONSOLE_LIGHTS_NAV_LIGHTS_SWITCH**.

Alternatively, with the BehaviourDebug menu open, moving your mouse over a switch and pressing [Ctrl]+[G] on your keyboard will automatically populate the search fields with that control’s LVAR. If you then copy and paste the LVAR name into the LocalVariables menu, it will show the value for each switch position.

CREDITS

Project management	Martyn Northall
Aircraft modelling and design	Mark Griffiths
Aircraft systems and cockpit programming	Martyn Northall
Aircraft liveries	David Sweetman
Flight dynamics	Paul Frimston
Sounds	SimAcoustics
EFB	Omniwise
Lead Tester	Mark Allison
Manual	Mark Allison, Mark Embleton
Installer	Richard Slater
Design	Fink Creative

Special thanks to all the testers and to the XM655 Maintenance and Preservation Society for giving us permission to photograph and record sounds of their aircraft.

COPYRIGHT

More Just Flight add-ons for Microsoft Flight Simulator

F28
PROFESSIONAL

FS Traffic

146
PROFESSIONAL

HAWK T1/A
ADVANCED TRAINER

PA-28R
TURBO ARROW III/IV

Just Flight™

Just Flight™

www.justflight.com