Black Square

TURBINE DUKE

OPERATIONS MANUAL

For Microsoft Flight Simulator

Published By:
Just Flight

"Virtual Aircraft. Real Engineering."

Turbine Duke User Guide

Please note that Microsoft Flight Simulator must be correctly installed on your PC prior to the installation and use of this Turbine Duke aircraft simulation.

Contents

Introduction

The Duke 60 was introduced in 1968 to fill a market for executive travel between the Baron series and the King Air 90 series. While the Baron and King Air remain in production today, selling over 10,000 combined aircraft, only 600 Duke airframes were manufactured between 1968 and 1983. Despite this, the Duke remains one of the highest performance twin engine piston aircraft in the market, and a cult favorite among aircraft owners. What could make the Duke even better? The Royal Turbine Duke conversion replaces the original 380 HP (280 kW) Lycoming TIO-541 engines with two 525 SHP (386 kW) Pratt & Whitney PT6A-35 turboprop engines. The resulting 1,000+ SHP aircraft is capable of cruising at 320 KTAS, around 30% faster than the reciprocating engine aircraft, with all the benefits of turboprop engines. There are only around 20 Turbine Duke conversions in the world, making them a rare breed of highly capable aircraft that are sought after by aircraft owners the world over.

Black Square's Turbine Duke brings you one of the most technically advanced aircraft simulations for Microsoft Flight Simulator, with over 130 possible failures including new turbine engine failures, 12 hot-swappable radio configurations, and the most advanced pressurization and cabin temperature simulations in MSFS. Black Square's new tablet interface lets you configure all options, manage payload, control failures, and monitor engines, electrical schematics, and environmental control systems, all from within the simulator. The failure system allows for persistent wear, MTBF, and scheduled failures for nearly every component in the aircraft. The Turbine Duke's electrical system is the most accurate yet for Black Square, featuring a battery temperature monitor, overvoltage protection, overcurrent protection, and AC inverters. The 3D gauges are modeled and coded to meticulously match their real world counterparts, with reference to real world manuals. No piece of equipment appears in a Black Square aircraft without a real world unit as reference. Radionavigation systems are available from several eras of the Duke's history, so users can fly without GPS via a Bendix KNS-81 RNAV system, or with the convenience of a Garmin GTN 750 (PMS50 or TDS). Other radio equipment includes KX-155 NAV/COM radios, KLN-90B, GTN 650, GNS 530, GNS 430, KR 87 ADF, KDI 572 DME, GTX 327 Transponder, Century IV Autopilot, and a Bendix RDR1150XL Weather Radar. A 160+ page manual provides instruction on all equipment, and 56 in-game checklists with control/instrument highlighting are included for normal and emergency procedures. The Turbine Duke conversion incorporates the "Grand Duke" performance package (winglets, vortex generators, strakes, extra fuel, increased speeds, and increased MGTOW). Three distinctive interiors and six paint schemes are included from three decades of flying.

Primarily analog instrumentation augmented with modern radionavigation equipment is still the most common aircraft panel configuration in the world. Challenge your piloting skills by flying IFR to minimums with a fully analog panel, and no GPS. You'll be amazed at the level of skill and proficiency you can achieve to conquer such adversity, and how it will translate to all your other flying. You also may find the analog instrumentation much easier to read with the limited number of pixels available on a computer monitor, and even more so in VR.

For more information on this product's capabilities and a list of all included avionics and equipment, see the extensive operating manual at www.JustFlight.com.

Feature Overview

Shared Features

Black Square's best aircraft yet will challenge you with unapologetically realistic systems, like…

- **160 page manual** with your complete guide to flying the Black Square Dukes, including systems guide, tutorials, operating limitations, performance tables, and electrical schematics
- **NEW TABLET INTERFACE!** for configuring options, payload settings, failure management, and real time visualizers for engines, electrical schematics, and environmental systems.
- **12 hot-swappable radio** configurations, configurable via tablet interface. Incl. PMS & TDS
- **130+ Random, scheduled, or performance triggered failures**, settable via the tablet interface, including engine damage, compatible with 3rd party UI's and instructor stations.
- **Fully simulated environmental control and pressurization system** for heating, air conditioning, ventilation, ram air cooling. Cool things off by opening a door, or watch the airplane heat up in the sun. Monitor via the new tablet interface.
- **NEW engine preheating** required for cold starts, with heater and ground power cart.
- **NEW voltage-based light dimming,** an immediately recognizable effect to nighttime pilots.
- **NEW gyroscope physics simulation** for electric and pneumatic gyroscopes with precession, and partial failures, based on a coupled quadrature oscillator.
- **NEW KLN-90B vintage GPS.** Download from https://github.com/falcon71/kln90b/releases
- **NEW strobe light system** causes realistic distracting flashes in clouds.
- **NEW St. Elmo's Fire** & static discharge on static wicks and windshields in severe weather.
- **NEW KNS-81 RNAV now supports autopilot** with No-GPS configuration.
- **Mathematically accurate VOR & ADF signal attenuation and noise degradation.**
- **Physics based instrument needles** bounce and respond to aerodynamic forces.
- Turbine engine failures, such as compressor stall and surging, and fuel control failures
- Improper engine management will slowly **damage engines to failure**.
- **Completely simulated electrical system**, with 100+ circuit breakers and failures
- **Functional exterior elements**: chocks, pitot covers, engine covers, propane preheater, and external power cart. Pitot cover flags blow in the wind.
- Carbon Monoxide leaks are possible, and can be detected with the CO detector.
- State saving for fuel, radio selection, radio frequency memory, cabin aesthetics, etc.

- Crew/Passenger oxygen depletes according to pressure altitude, passenger occupancy.
- Ultra-custom dynamic registration number system for livery creators.

Turbine Duke Specific Features

- **NEW improved turboprop dynamics**, including (ITT, TRQ, Ng, FF, FP), hot starts, residual heat, and exhaust back pressure, P2.5 HP & LP valve simulation, and oil cooler doors.
- **NEW turbine engine failures**, such as compressor stall and surging, fuel control failure, fuel filter clogs, propeller governors, and fire suppression systems.
- **NEW FOD damage based on surface type.** Use the inertial separators to avoid engine damage. Tablet interface displays type and intensity of FOD.
- **NEW turbine engine propeller and feathering physics-driven simulation.**
- **NEW beta range simulation**: an improvement upon the Black Square TBM beta range.
- **ETM Engine Trend Monitor**. Dual Battery temperature monitor, and AC inverter logic

Checklists

Over 500 checklist items are provided for 56 Normal, Abnormal, and Emergency procedures in textual form in the manual, and in-game, using the MSFS native checklist system with control and instrument highlighting. If it's in the checklist, it's settable in the aircraft!

Sounds

Black Square's Duke features a custom soundset created by Boris Audio Works with care to the unique operating aspects of this classic aircraft. High quality engine and cockpit sounds will immerse you in the simulation. Sounds like engine starting are not mere recordings, but instead many layered sounds, constructed based on the underlying simulation.

Flight Dynamics

The Turbine Duke features a flight model with performance to match the real world aircraft based on real Duke owner feedback and in-flight data. Engine and aerodynamic performance should be within 2% of POH values, though no two engines are ever the same. The flight model uses the most up to date features available in MSFS, such as CFD propeller and stall physics, and SU15 improved ground handling and flexible tire physics. Engine damage and fouling produces a rough running engine and decreased performance.

Aircraft Specifications

Length Overall	33’10”
Height	12'4"
Wheel Base	9’8"
Track Width	10’10"
Wingspan	39’10”
Wing Area	212.9 sqft.
Flight Load Factors	+3.5/-1.2 G’s (+2.0/-1.1 G’s with Flaps Down)
Design Load Factor	150%
Cabin W/L/H	50" x 11’10” x 52"
Baggage Capacity	Nose: 330 lbs (32 cuft) Aft Cabin: 70 lbs
Oil Capacity	2.3 U.S. Gallons / Engine
Seating	6
Wing Loading	31.8 lbs/sqft
Power Loading	6.76 lbs/hp
Engines	525 SHP (390 kW) Pratt & Whitney PT6A-35 Free-Turbine
Propellers	4-Blade Hartzell, Constant Speed, Fully Reversible, Aluminum, Hydraulically Actuated, 80.5 inch propeller. Fully fine blade angle of 15.0°, Low pitch blade angle of 59.5°, feathering angle of 85.0°.
Approved Fuel Grades	JET A (ASTM-D1666) JET A-1 (ASTM-D1666) JET B (ASTM-D1666) JP-4 (MIL-DTL-5624) JP-5 (MIL-DTL-5624)
Fuel Capacity	Total Capacity: 270.9 Total Usable: 265.9 Capacity Each Tank: 138.4 (left) 132.5 (right) Usbale Each Tank: 135.9 (left) 130.0 (right)
Electrical System	
Voltage:	28 VDC
Batteries:	24V, 15 amp-hour, sealed lead acid battery
Generators:	28V, 200 amp @ 2,500 RPM, each engine
Pressurization System	4.7 PSI Maximum Pressure Differential Pressurization Rate Controller 150 ft/min to 2,000 ft/min Minimum/Maximum attainable altitude -1,000 ft / 15,000 ft Pressure Vessel Structural Life Limit: 15,000 hours

Aircraft Performance (Turbine Duke)

Maximum Cruising Speed	320 ktas
Normal Cruising Speed	290 ktas
Economy Cruising Speed	225 ktas
Takeoff Distance	1,000 ft
Takeoff Ground Roll	820 ft
Landing Distance	850 ft
Landing Ground Roll	400 ft
Accelerate/Stop Distance	1,290 ft
Normal Range (30 min. reserve)	1,235 nm
Maximum Range (30 min. reserve)	1,540 nm
Rate of Climb	2,650 ft/min
Single Engine Rate of Climb (feathered)	740 ft/min
Single Engine Rate of Climb (windmilling)	50 ft/min
Service Ceiling	28,000 ft
Empty Weight	4,553 lbs
Max Ramp Weight	7,039 lbs
Max Takeoff Weight	7,000 lbs
Max Landing Weight	7,000 lbs
Useful Load	2,447 lbs
Usable Fuel Weight	1,595 lbs
Full Fuel Payload	852 lbs
Maximum Operating Temp.	+38°C
Minimum Operating Temp.	-54°C

Maximum Demonstrated Crosswind Component: 25 kts

V-Speeds (Turbine Duke)

Vr	102 kts	(Rotation Speed)
Vs	80 kts	(Clean Stalling Speed)
Vso	70 kts	(Dirty Stalling Speed)
Vmc	96 kts	(Minimum Controllable Speed w/ Critical Engine Inoperative)
Vx	110 kts	(Best Angle of Climb Speed)
Vy	120 kts	(Best Rate of Climb Speed)
Vxse	110 kts	(Best Single Engine Angle of Climb Speed)
Vyse	120 kts	(Best Single Engine Rate of Climb Speed)
Va	158 kts	(Maneuvering Speed)
Vg	115 kts	(Best Glide Speed)
Vfe	140 kts	(Maximum Full Flap Extension Speed)
Vfa	174 kts	(Maximum Approach Flap Extension Speed)
Vle	174 kts	(Maximum Landing Gear Extension Speed)
Vne	198 kts	(Do Not Exceed Speed)

Engine Limitations

Engine Speed	2,190 RPM (2,410 RPM Monetary)
Torque (below 17,500 ft)	1,260 FT-LBS
Torque (above 17,500 ft)	1,200 FT-LBS
ITT	805°C (T/O) 770°C (Climb) 770°C (Cruise) 1090°C (Starting)
Gas Generator	101.5% (Continuous) 102.6% (Momentary) 101.5% (Reverse)
Oil Temperature	50°F (10°C) (min.) 210°F (99°C) (max.)
Oil Pressure	40 PSI (min.) 100 PSI (max.)
Fuel Pressure	15-30 PSI (normal)

Other Operating Limitations

- When ITT exceeds 770°C, time at this power setting should be limited to 5 minutes.
- Reverse thrust operation limited to durations of one minute.
- Aircraft shall not be operated when outside takeoff temperature exceeds 100°F (38°C).
- BOTH the Wing Pump and Aux Pump for each engine must be functional for takeoff.
- Do not take-off when fuel quantity gauges indicate in the yellow arc, or with less than 25 gallons in each tank.
- Maximum slip duration: 30 seconds.
- Do not attempt to fully retract landing gear with manual hand crank handle. Doing so may cause damage to worm gear shaft.

Starter Limitations

Using Airplane Battery:

30 seconds ON - 60 seconds OFF
30 seconds ON - 60 seconds OFF
30 seconds ON - 30 **minutes** OFF

Using External Power:

20 seconds ON - 120 seconds OFF
20 seconds ON - 120 seconds OFF
20 seconds ON - 60 **minutes** OFF

Paint Schemes

The Black Square Turbine Duke comes with six paint schemes. The Turbine Duke also comes with three interior upholstery packages. This product makes use of Black Square's highly customizable dynamic tail number system, which can be configured by livery makers. See the "Custom Dynamic Tail Numbers" section of this manual for more information.

At the time of release, 10+ community-made paint schemes are already available for download on www.flightsim.to. Install liveries just by dragging them into your community content folder.

Instrumentation/Equipment List

Main Panel

- Master Warning/Caution
- Annunciator Panel
- True Airspeed Indicator
- Century 1U367 Steering Attitude Indicator
- Century NSD-360 Horizontal Situation Indicator (HSI)
- Bendix/King KEA-346 Encoding Altimeter
- Collins RMI-30 Radio Magnetic Indicator (RMI)
- Vertical Speed Indicator
- Bendix/King KI 206 Localizer
- Mid-Continent Turn Coordinator
- Bendix/King KRA-10 Radar Altimeter
- Digital Engine Instrumentation
- Digital Fuel Quantity Indicators
- Bendix/King KI-227 ADF Indicator
- BTI-600 Dual Battery Temperature Monitor
- Duplicate Copilot Instrumentation

Avionics

- Garmin GMA 340 Audio Panel
- Bendix/King KMA 24 Audio Panel
- Garmin GTN 750/650 (Com1/Com2)
- Garmin GNS 530/430 (Com1/Com2)
- Bendix/King KLN-90B
- Mid-Continent MD41-328 GPS Annunciator Control Unit
- Bendix/King KX-155B (Com1/Com2)
- Bendix/King KNS-81 RNAV Navigation System
- Bendix/King KR 87 ADF
- Bendix/King KDI 572R DME
- Century IV Autopilot
- Collins PRE-80C Altitude Preselector
- ETM Engine Trend Monitor
- Bendix RDR 1150XL Color Weather Radar
- Garmin GTX 327 Transponder

Electrical/Miscellaneous

- 70+ Circuit Breakers
- Voltmeter & Ammeters
- Fire Detector & Extinguishers
- Instrument Air Indicator

- Deicing Boot Pressure Indicator
- Oxygen Pressure Gauge
- Yoke-Mounted Digital Chronometers
- Tach Timers
- Carbon Monoxide Detector
- Cabin Pressurization Controller
- Cabin Environmental Control System

Installation, Updates & Support

Installation

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

1. Click on the ‘Account’ tab on the Just Flight website.
2. Log in to your account.
3. Select the ‘Your Orders’ button.
4. A list of your purchases will appear and you can then download the software you require.
5. Run the downloaded installation application and follow the on-screen instructions

If you already have an earlier version of this software installed, the installation application will detect this and update your existing software to the new version without you needing to uninstall it first.

NOTE: THE FOLLOWING DOWNLOADS ARE OPTIONAL, and not required to enjoy the base functionality of this Black Square aircraft; however, they are highly recommended for the most immersive experience possible.

Installing the PMS GTN 750/650

1. Go to the following link, and click download for the **FREE GTN 750 Mod.**
   https://pms50.com/msfs/downloads/gtn750-basic/
2. Move the “pms50-instrument-gtn750” archive (zipped folder) from your browser’s download location (downloads folder by default) to your desktop, and extract (unzip) the archive by right clicking, and selecting “Extract All”.
3. Drag the resulting “pms50-instrument-gtn750” folder into your Microsoft Flight Simulator Community Folder.

   If you don’t know how to locate your MSFS Community Folder, you should be able to find it in one of the following locations, based on the service you used to purchase the simulator.

   For the Windows Store install:

   C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightSimulator_8wekyb3d8bbwe\LocalCache\Packages\

   For the Steam install:

   C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightDashboard_8wekyb3d8bbwe\LocalCache\Packages\

Important: Windows 10 by default hides the "AppData" folder, so you will have to go to "View" in the menu of File Explorer, and select "Hidden items" so as to see it.

For the Custom install:

If you used a custom location for your Flight Simulator installation, then proceed there.

For example, you may have set:
E:\Steam\steamapps\common\MicrosoftFlightSimulator\Community

Installing The Working Title GNS 530/430

The Working Title GNS 530/430 is now in public beta, and downloadable for free from the in-game marketplace. It is recommended that users discontinue use of the PMS50 GNS 530 freeware mod in favor of the WT GNS, which has many more features, and a significantly more realistic display. The WT GNS is expected to become a part of the base simulator soon.

To download and install the Working Title GNS 530/430, click the "MARKETPLACE" tile in the MSFS main menu, and use the search bar to find "GARMIN GNS 430/530" by "Working Title Simulations". After clicking the "GET AND DOWNLOAD" button, the GPS will be ready to use.

TDS GTNxi 750/650 Integration

This aircraft's GTN 750 unit will automatically detect a valid TDS GTNxi installation and license key, and automatically switch between using the PMS GTN 750 and the TDS GTNxi 750 without any required action by the user.

The TDS GTNxi is available from: **https://www.tdssim.com/tdsgtnxi**

LIMITATIONS:

MSFS native GPS units and native flight planners will not cross-fill from the GTNxi. This could also be seen as an advantage, allowing simultaneous flight plan loading.

NOTE: These are limitations of MSFS and not this aircraft, nor the TDS GTNxi. If and when these issues are resolved, a coordinated effort from the developers of these products will be launched to remove these limitations as soon as possible.

Installing The Falcon71 KLN-90B

1. Go to the following link, and click download for the **FREE KLN-90B Mod.**
   https://github.com/falcon71/kln90b/releases
2. Move the “falcon71-kln90b-vX.XX” archive (zipped folder) from your browser’s download location (downloads folder by default) to your desktop, and extract (unzip) the archive by right clicking, and selecting “Extract All”.
3. Drag the resulting “falcon71-kln90b” folder into your Microsoft Flight Simulator Community Folder.

   If you don’t know how to locate your MSFS Community Folder, follow the instructions in the “Installing the PMS GTN 750/650” section of this manual, above.

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 ‘B60 Duke’, or the ‘Turbine Duke’ by Black Square.
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 ‘Uninstall’ 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 Twitter.

Liveries & Custom Dynamic Tail Numbers

This aircraft is the first to debut Black Square's highly customizable dynamic registration number system. This system allows livery creators to adjust many features of how registration numbers are displayed on the aircraft. The following image shows all the areas on the aircraft where a tail number can be positioned (in blue).

For those interested in creating custom liveries, a custom PANEL.CFG file should be included in the livery package, and referenced via the livery's AIRCRAFT.CFG. In this PANEL.CFG, the [VPainting01] section, specifically the "painting00" can be edited to alter the appearance of the tail number. The parameters between the '?' and the ',' separated by '&', control the tail number. Below is an example tail number configuration, followed by an explanation of all the parameters.

font_color=red&stroke_size=30&stroke_color=black&sv=1&sx=18&sy=41&sr=0&sk=20&ss=250&tv=1&tx=16&ty=8&tr=0&tk=20&ts=225&wv=1&wx=32&wy=20&wr=9&wk=30&ws=150

Each position ("s" = side, "t" = tail, and "w" = winglets) has the following associated variables:

"v" = whether to show the tail number in that position (0=false, 1=true)

"x" = the nose-tail position of the tail number

"y" = the top-bottom position of the tail number

"r" = the rotation of the tail number (will accept decimals)

"k" = shears the tail number, positive values shear top towards tail

"s" = the font size of the tail number

Example "tk=30":   t = tail, k = skew. This will shear the registration on the tail towards the tail of the aircraft by 30 degrees.

These values can be edited live using the Coherent GT Debugger from the MSFS SDK.

Tail Number Positioning:

Side +X -> Forward, -Y -> Up

Tail -X -> Forward, -Y -> Up

Wing -X -> Forward, -Y -> Up

Unlike the default dynamic tail number system, these tail numbers will not automatically resize, so make sure there is room for a full six character registration.

New fonts can be added in livery packages, and any font/outline/shadow color may be selected from the standard JavaScript colors by name, or by Hex Code.

The resolution of the tail numbers can be adjusted with the resolution values at the end of the painting00 entry, and the "size_mm" entry above. Large resolutions may affect performance.

Cockpit & System Guide

Main Panel

Master Warning/Caution

The Turbine Duke is equipped with Master Caution, and Master Warning annunciators with integrated push buttons above the pilot's airspeed indicator. The Master Caution annunciator illuminates with yellow "MASTER CAUTION" text, and the Master Warning annunciator illuminates with red "MASTER WARNING" text. Both are latching annunciators, meaning that they illuminate when triggered by a specific aircraft condition, and remain illuminated until canceled by a crew member by pressing the annunciator's integrated push button.

A Master Warning is triggered by any condition that illuminates on the annunciator panel in RED. These conditions require immediate pilot action to rectify. A Master Caution is triggered by any condition that illuminates on the annunciator panel in AMBER. These conditions likely require pilot action to rectify, and might lead to a more severe condition if not rectified soon.

Annunciator Panel

The Turbine Duke's annunciator panel consists of two LED annunciator panels located atop the center main panel, with 20 indicator lamps each.

The annunciator text color indicates the severity of the condition. RED conditions are flight critical, and require immediate pilot action to rectify. AMBER conditions will likely result in a more severe condition if pilot action is not taken to rectify the condition soon. GREEN annunciators denote a condition which is neither harmful, nor potentially harmful, but may be undesirable depending on the phase of flight. BLUE annunciators pertain to ice mitigation or environmental control systems. To test the annunciator panel, press and hold the small white push button in the center of either panel. The annunciator panel is dimmed with a toggle switch on the fire detector panel to the left of the annunciator panel. The annunciator panel receives power through the "Annun Panel" circuit breaker on the copilot's upper side panel.

The following text illuminates to indicate the associated condition. Duplicate conditions for the left and right engines have been omitted.

ENG FIRE (RED)	Engine fire detected
CHIP DETECT (RED)	Metal particulate detected in the engine oil
FUEL LOW (RED)	Fuel remaining < 15 gallons
OIL PRESS (RED)	Oil pressure < PSI
OIL TEMP (RED)	Oil temperature greater than ~100°C
FUEL PRESS (RED)	Fuel pressure < 5 PSI
GEN FAIL (RED)	Generator inoperative
INVTR FAIL (RED)	Loss of AC Avionics Power
LOW VOLTS (RED)	Main bus voltage < 25V
INST PRESS (RED)	Instrument pressure < 2.5 PSI
CABIN ALT (RED)	Cabin altitude > 12,500 FT
CABIN DIFF (RED)	Cabin differential pressure > 4.7 PSI
CABIN DOOR (RED)	Cabin door open or unlatched
ENG START (AMBER)	Starter engaged
ENG IGN (AMBER)	Engine ignition on
FUEL FILTER (AMBER)	Fuel filter differential pressure indicates clogged filter
PITOT HT OFF (AMBER)	Pitot heater off
OIL DOOR CLSD (AMBER)	Oil cooling door closed
OIL DOOR OPEN (GREEN)	Oil cooling door open
ICE DR OFF (GREEN)	Inertial separator (ice deflector) off
ICE DR ON (BLUE)	Inertial separator (ice deflector) on
SURF DEICE (BLUE)	Deicing boots pressurized
WSHLD HEAT (BLUE)	Windshield heat AC inverter on
AC ON (BLUE)	Air Conditioning system on and condenser door open
PROP HEAT (BLUE)	Propeller heat activated

True Airspeed Indicator

The Turbine Duke’s airspeed indicator displays indicated airspeed in knots, reference speeds with colored arcs, and true airspeed on a white tape through the bottom window. The red marking corresponds to the never-exceed speed. The lower end of the green arc corresponds to the clean configuration stalling speed. The upper end of the white arc corresponds to the maximum flap operating speed, and the lower end of the white arc corresponds to the full flap stalling speed. Two additional radial marks are relevant to twin engine aircraft operation. The red line indicates Vmc, or minimum controllable speed with a single engine operating, and the critical engine inoperative. The blue line indicates the best single engine operating climb speed. A small white triangle indicates the maximum landing gear extension airspeed, and maximum approach flap setting airspeed. The airspeed indicator also includes a true airspeed calculator, which can be positioned for pressure altitude and air temperature, much like an E6B flight computer, to produce the true airspeed indicated in the bottom window.

Century 1U367 Steering Attitude Indicator

The Century 1U367 is a vacuum powered artificial horizon with adjustable attitude bars and a single-cue flight director. The attitude bars are adjusted with the unlabeled knob on the bottom right of the unit. When paired with a Century autopilot, the 1U367 is capable of driving integrated attitude commend bars via the autopilot's flight director output. The command bars will automatically compensate for the adjusted position of the static attitude bar, and will be hidden from view when not in use. Turning the "FD" knob clockwise will engage the flight director if the unit is receiving a valid signal. Turning the knob back to the left will hide the flight director.

NOTE: This attitude indicator is equipped with Black Square's highly accurate gyroscope dynamics simulation. Users can experience the multitude of gyroscope dynamics and failures inherent to the operation of these instruments. The partial or complete failure of gyroscopic instruments can surprise pilots and result in catastrophic loss of spatial awareness. For more information on Black Square's gyroscope simulation, see the "Gyroscope Physics Simulation'' section of this manual.

Century NSD-360 Horizontal Situation Indicator (HSI)

The Century NSD-360 has an automatically controlled compass card, as opposed to most directional gyroscopic compass units, which can be automatically slaved to magnetic heading. The HSI has two knobs, one for controlling the green heading bug for autopilot heading hold mode, and one for adjusting the course indicated with the yellow needle in the center of the display. The HSI in this aircraft can be controlled by the NAV1 receiver source (VLOC), the NAV1 GPS signal (GPS), or the RNAV source. The RNAV source is selected with the switch located above the autopilot auxiliary mode annunciator panel.

The split yellow needle acts as a course deviation indicator, where the deviation scale depends on the navigation source, and operational mode, such as enroute GPS, or ILS antenna signal. On the left of the unit is a normally hidden and flagged, yellow, glideslope indicator needle, which comes into view when the glideslope signal is valid. Under the yellow course indicating needle, two windows with white indicators show the traditional to/from VOR indication when a VOR radio source is selected.

When no navigation source has a valid signal, a red and white “NAV” flag appears in the center of the display. When no valid signal is received from the remote compass, a red and white “HDG” flag appears at the top right of the display. When the unit is not receiving power, both flags are visible.

The NSD-360 acts as the remote compass controller, along with a “Gyro Slave/Free” mode switch above the copilot’s altimeter. The purpose of a remote compass is to supply several instruments, autopilots, or navigation systems with a reliable source of magnetic compass direction that is continuously correcting for gyroscopic drift. This is accomplished by integrating a fluxgate magnetometer’s sensing of magnetic direction with a larger gyroscope than could fit within the housing of a single panel-mounted instrument. This remote compass erects to the correct magnetic heading when powered on, and will automatically correct for gyroscopic drift throughout the flight when the mode is placed in the “SLAVE” position. In this mode, the NSD-360’s integrated synchroscope needle in the upper right corner of the instrument should be centered between the + and - markings. Should the position of the remote compass become unreliable, such as during flight through magnetic disturbances or over the earth’s poles, the remote compass can be placed in a manual mode by placing the mode switch in the “FREE” position. In this mode, the input of the magnetometer will be ignored, and the unit will behave like a normal directional gyroscope. The position of the remote compass can be controlled by depressing the heading bug control knob, labeled “PUSH CARD SET”, and rotating the knob. In this mode, the synchroscope will show the set compass position’s deviation from the detected magnetic heading. During normal operation, the integrated synchroscope needle should be observed oscillating about the centered position. This confirms that the system is functioning properly.

NOTE: It was previously not possible to drive the autopilot from RNAV source. This limitation has been eliminated, starting with this aircraft. The autopilot will only use the KNS-81 as a navigation source when the no-GPS avionics configuration is selected from the tablet interface. Press the navigation source button to illuminate its “RNAV” annunciator. Use the toggle switch above the attitude indicator to select “RNAV” as the HSI source.

Bendix/King KEA-346 Encoding Altimeter

The KEA-346 is a single needle type altitude indicator with a digitally controlled three-drum indicator for altitude, and two mechanically controlled four-drum indicators for barometric indication in millibar and inches of mercury. When the unit is not receiving power, a red and white flag covers the altitude indicating drums. The barometric setting is controlled via an adjustment knob on the face of the unit. The pilot's altimeter is the encoding altimeter used for the Mode-C transponder output, and to drive the altitude hold function of the Century IV autopilot.

Collins RMI-30 Radio Magnetic Indicator (RMI)

This RMI has an automatically rotating compass card that is driven via the aircraft's remote compass, and therefore, has no adjustment knob like an ADF. The solid yellow needle of the RMI can display the bearing to either the station tuned in the NAV1 radio, or the ADF1 radio. The hollow green needle can display the bearing to either the station tuned in the NAV2 radio, or the ADF2 radio. Both needles will point directly to the tuned radio ground station whenever signal strength is sufficient. To swap which source is used for either needle, press the illuminated push buttons on the face of the unit. Since there are no flags on this unit to indicate reception, it is necessary to properly identify the station via its morse code identifier before using the RMI indications as a source of navigation. The RMI will show a red flag when the unit is not receiving power, or when the unit is not receiving signal from the remote compass.

NOTE: While this unit is capable of displaying information from two ADF units, this aircraft is only equipped with a single ADF receiver, which can be displayed on either needle.

NOTE: This is the only piece of avionics in the aircraft powered by alternating current.

Vertical Speed Indicator

A vertical speed indicator displaying a maximum of +/- 4,000 feet per minute. This instrument will display slipstreaming effects from the turbulent propeller wash passing over the static ports on the rear of the aircraft.

Bendix/King KI 206 Localizer

The KI 206 Localizer acts as a secondary radionavigation source in this aircraft, being permanently driven by the NAV2 VOR radio source. The KI 206 includes both lateral and vertical guidance needles, which can be driven from a VOR/ILS receiver, the GNS 430W, or the GTN 650. The unit incorporates both vertical “GS”, and horizontal “NAV” red flags to indicate when the unit has power, and when the respective navigation source is being received. Two windows with white indicators show the traditional to/from VOR indication when a VOR radio source is selected. This unit is not connected to the remote compass, and therefore, must be manually adjusted for the desired course with the omni-bearing-selector (OBS) knob on the unit’s face.

Mid-Continent Turn Coordinator

A DC electric turn coordinator with indicator markings for a standard rate 2-minute turn, a traditional slip indicator, and a red power flag to indicate when the unit is not receiving power.

Bendix/King KRA-10 Radar Altimeter

The KRA-10 Radar Altimeter displays the height of the belly-mounted radar transducer with respect to the terrain below the aircraft. The yellow indicating needle rests in a vertical "OFF" position when the unit is not receiving power, a valid signal, or when the indicated altitude is below 10 feet. An orange decision height bug can be positioned from 0 to 2,500 feet on the indicating scale with the adjustment knob. When passing the decision height in a descent, the integrated, yellow, decision height indicator will illuminate, as well as the connected indicator on the KI 256 attitude indicator. Be aware that the indicating scale is non-linear.

Digital Engine Instrumentation

A cluster of six engine instrument pairs resides to the right of the pilot's main instrument panel. From top to bottom, they are; Torque (FT-LBS), Interstage Turbine Temperature (ITT) (°C), Gas Generator RPM (Ng%) (% rated RPM), Propeller RPM, Fuel Flow (GPH), Fuel Pressure (PSI). The fuel quantity gauges have an integrated 7-segment display for increased precision.

Two digital engine oil instruments in the center subpanel indicate oil temperature (°F) on the left, and oil pressure (PSI) on the right.

NOTE: See the "Engine Power Settings" section of this manual for proper operating technique.

Digital Fuel Quantity Indicators

On the pilot's right subpanel, above the lighting controls, there are two fuel quantity indicators. The fuel indicators are marked in gallons. In Turbine Duke has approximately 34 gallons of additional fuel compared to the Piston Duke Grand Duke upgrade kit. The left tank has a capacity of 135.9 gal with 130.0 usable, and the right tank has a capacity of 138.4 gal with 132.5 gal usable. Takeoff is not permitted when either fuel quantity is within the marked yellow arc, or below 25 gallons. Each digital fuel gauge has an integrated low fuel warning light that illuminates red when the fuel quantity in the associated tank is below approximately 15 gallons. The fuel quantity gauges have an integrated 7-segment display for increased precision.

NOTE: Conventional fuel sender units in aircraft are notoriously sensitive to lateral G-force, and how level the aircraft is sitting on the ground. The fuel quantity gauges may appear to indicate incorrectly, as a result, though this is accurate to the real aircraft. Given that this aircraft is also capable of random fuel leaks, fuel levels should be checked prior to takeoff, just as in the real aircraft, when any potential discrepancy exists.

BTI-600 Dual Battery Temperature Monitor

This aircraft is equipped with a realistic battery temperature simulation. The original aircraft shipped with nickel cadmium batteries from the factory, which made it particularly susceptible to battery overheating. The BTI-600 is an electrically powered instrument that displays battery terminal temperature with an orange indicating needles. Two integrated warning lights are activated when either needle enters the yellow and red colored temperature bands; yellow for “Warm” and red for “Hot”. When the unit is off, the orange needle will rest at the top of the scale on the word “OFF”. Otherwise, if the temperature is low, the needle will rest at the bottom of the scale in the hatched area. The “Warm” temperature band is approximately 120°F to 150°F, and the “Hot” temperature band is 150°F and above.

NOTE: The temperature of the batteries and state of the aircraft’s electrical system can be monitored via the electrical page of the tablet interface. For more information on the tablet’s engine pages, see the “Live Schematic Page” section of this manual.

Duplicate Copilot Instrumentation

A conventional six-pack of primary flight instruments is included on the co-pilot's side of the aircraft, including an airspeed indicator, artificial horizon, three pointer altimeter, gyroscopic heading indicator, turn coordinator, and vertical speed indicator. To best serve as backup instrumentation in case of a vacuum failure, the artificial horizon and directional gyroscope are electrically powered. A second Bendix/King KI 206 Localizer unit is included which permanently displays signals from the KNS-81 RNAV computer. Also on the copilot's side is a Bendix/King KI-227 ADF indicator, with manually positioned card compass.

Avionics

Black Square aircraft have reconfigurable radio panels that allow you to fly with many popular radio configurations from old-school no GPS panels, to modern installations with touchscreen GPS navigators. Unlike previous Black Square aircraft, the radio configuration is selected via the options page of the tablet interface. The radio selection will be automatically saved and reloaded at the start of a new flight.

NOTE: For more information on radio hot-swapping and selecting an avionics package through the tablet interface, see the "Options Page" section of this manual.

Garmin GMA 340 Audio Panel

This audio controller is very common in light aircraft, and allows for the control of both receiving and transmitting audio sources on one panel. In addition, this implementation also supports listening to multiple VHF communication sources at once, and transmitting on both Com1 and Com2 by pressing the "COM 1/2" button. When you want to return to normal operation, press one of the "COM MIC" keys, and the integrated "COM 1/2" button indicator should extinguish.

KMA 24 Audio Panel

This audio controller is common in older light aircraft, and allows for the control of receiving and transmitting audio sources, and cabin speaker sources. The transmitting channel may be selected with the rotary selector knob on the right of the unit, from the following options: Unit off (OFF), Radiotelephone (TEL), COM 1, COM 2, Cabin Interphone (INT), and External Interphone (EXT). The unit possesses two rows of toggling push button selector switches to choose audio receiving sources. The top row is used to select an unlimited number of simultaneous audio sources for the cabin speaker, while the bottom row selects sources for the headphone circuit. Only the bottom row has an effect on the audio source within the simulation.

Garmin GTN 750/650 (Com1/Com2)

This modern touchscreen GPS is implemented by a 3rd party developer. For installation instructions, and instructions on its use, see the installation section of this manual, or the developer's website. **Both PMS GTN 750/650 and TDS GTNxi 750/650 products are supported.** The aircraft will automatically switch between the installed software with no required user action.

PMS50 GTN 750/650

TDS GTNxi 750/650

NOTE: To switch between PMS and TDS products while the aircraft is loaded, toggle the PMS/TDS switch in the avionics selection section of the tablet interface's options page. For more information on radio hot-swapping and selecting an avionics package through the tablet interface, see the "Options Page" section of this manual.

Garmin GNS 530/430 (Com1/Com2)

This 2000's era full-color GPS is mostly or partially implemented by a 3rd party developer. For installation instructions, and instructions on its use, see the installation section of this manual, or the developer's website.

NOTE: To hear an audible radio station identifier, both the small adjustment knob on the GNS must be pressed, and the appropriate NAV receiver switch must be activated on the integrated audio control panel.

Bendix/King KLN-90B

This 1990's era monochrome GPS with limited graphical mapping ability comprises a highly capable GPS unit with many features that are found in modern GPS units for pilots willing to learn the subtleties of the system. This GPS is implemented by a 3rd party developer. For installation instructions, and instructions on its use, see the installation section of this manual, or the developer's website.

NOTE: This GPS does not have integrated COM or NAV radios, and therefore must be used in conjunction with a KX-155 as COM/NAV1.

Mid-Continent MD41-328 GPS Annunciator Control Unit

The GPS Annunciator Control Unit is included to enable the full functionality of the KLN-90B, but retains limited functionality with other GPS units. The NAV/GPS button may be used to control the HSI and autopilot course signal with any GPS unit. The GPS/APR button is used specifically for arming the KLN-90B's approach mode. The OBS/LEG button may be used to toggle OBS mode for any GPS that has this functionality, but is specifically designed to be used with the KLN-90B. The annunciator lights will depict the present modes of operation for any GPS installed.

Bendix/King KX-155B (Com1/Com2)

This 1990's era Com/Nav receiver allows you to control audio and navigation source inputs from two independent communication and navigation antennas, the left side controlling the VHF Com radio, and the right controlling the VHF Nav radio. Frequency tuning increments can be toggled by pulling on the inner knob of the COM side (labeled "PULL 25K"). The small adjustment knob on the Com side of the unit controls receiver volume, and can be pulled to toggle between US and European frequency spacing. The smallest tunable increment in US mode is 25 kHz, and the smallest possible increment in European mode is 8.33 kHz. The COM display will show frequencies with three decimal places when in 8.33 kHz mode, and two decimal places in 25 kHz mode. When the inner frequency adjustment knob on the NAV side is pulled, the same frequency adjustment knob will tune the active NAV frequency, and the standby frequency will be flagged with dashes. Additionally, a small "T" symbol will be displayed between the active and standby COM frequencies whenever the radio is transmitting. The small adjustment knob on the Nav side of the unit controls Nav receiver identifier volume, and can be pulled for an audible identifier tone.

NOTE: To hear an audible radio station identifier, both the small, right adjustment knob on the KX155 must be pulled out, and the appropriate NAV receiver indicator light must be illuminated on the GMA 340 Audio panel.

Bendix/King KNS-81 RNAV Navigation System

See the standalone section of this manual for instructions on using the KNS-81, below. All stored frequencies, radials, and offsets associated with this unit will be automatically saved and recalled at the beginning of a new flight.

NOTE: The autopilot in this aircraft is capable of receiving navigation input from the KNS-81, but will only do so when the no-GPS avionics configuration is selected from the tablet interface. When operating without a GPS, the navigation source selector button and integrated annunciators will read "VLOC/RNAV", instead of "VLOC/GPS". For more details, see the "Flying an RNAV Course with the Autopilot" section of this manual.

Bendix/King KR 87 ADF

The KR 87 ADF receiver allows for standby ADF frequencies to be selected with the dual concentric rotary knobs on the right of the unit. When tuning a frequency, you will be editing the standby frequency, which can be swapped into the active frequency by pressing the “FRQ <->” push button. The two push buttons to the right of the “FRQ <->” button are for controlling the integrated flight timer. The “FLT/ET” push button toggles between the flight duration timer, which is automatically started when power is applied, and the elapsed time timer, which is started, stopped, and reset with the “SET/RST” push button. On the left of the unit, the “ADF” push button toggles the ADF receiver’s antenna mode between normal operation, and listening to the sense-only antenna (disabling the loop antenna), which makes receiving audio-only transmissions easier in low signal strength conditions. Lastly, the “BFO” push button toggles the unit’s beat frequency oscillator, which is used to listen to the tuned station’s morse code identifier in low signal strength conditions.

Bendix/King KDI 572R DME

This implementation of a KDI 572 behaves similarly to any other Distance Measuring Equipment (DME) receiver, displaying a nautical mile distance to the selected and tuned station, the current speed of the aircraft relative to the selected and tuned station, and a time-to-go until over the station. It should be noted that, like all other DME displays, this one is similarly dependent on being within the VOR service volume, and having good line-of-sight reception of the station. It should also be noted that these distances, speeds, and times, are based on slant-range to the station, not distance along the ground, as one would draw on a map. In order to receive DME information on the KDI 572, the station must be tuned in one of the two navigation radios, the station must be equipped with DME transmitting equipment, the station must have adequate signal strength, and the KDI 572 must have the appropriate navigation source selected via the selector knob mounted on its face.

Selecting “HLD” mode will hold the current DME frequency and information on the unit, while allowing the user to change the tuned NAV frequencies on the NAV1 or NAV2 radios. This can be useful for some specific instrument approaches. This unit’s state will be automatically saved and reloaded at the start of the next flight.

The “R” designation of this unit is of fictional nature to indicate that it possesses an additional switch position for viewing RNAV DME information from the KNS-81. When the rotary selector switch is placed in the RNAV position, “RNV” will annunciate to the right of the distance information. In normal operation, the unit will display DME information from the KNS-81, just like any other DME source. When the “RAD” two-position button is depressed on the KNS-81, however, the time (MIN) field will read “F”, for “From”, to indicate that the speed field (KT) is displaying the radial FROM the waypoint or VOR upon which the aircraft currently sits. When is radial mode, the “KT” and “MIN” annunciators will not be illuminated.

Century IV Autopilot

The Century IV Autopilot is a relatively simple autopilot, with standard modes of control, which resemble the operation of other light aircraft autopilots that users may already be familiar with. The autopilot possesses a master on/off button, labeled “AP” on the left of the mode control panel. Below this, a red button, labeled “test”, will illuminate all the indicator lamps, except “HDG” and “ATT”, as these are always illuminated when the autopilot is active. This unit has internal integrity lighting, which is controlled via the “PED” lighting dimmer on the lighting control panel.

NOTE: The pitch trim power switch, located to the right of the panel lighting dimmers, must be in the on position for the autopilot servos to control the aircraft.

The autopilot mode control buttons on the unit are split into horizontal modes in the top row, and vertical modes on the bottom row. Every mode should be familiar to users already with the exception of “ATT” attitude holding mode.

While most modern autopilots have a means for selecting a desired altitude and vertical speed to reach it, the Century IV instead uses pitch information only to control the aircraft's vertical profile to a desired altitude. Pressing the "ATT" button in flight will synchronize the autopilot's pitch holding reference with the aircraft's current pitch. Unlike a rocker switch or digital rotary knob, this will physically position the pitch control roller knob on the right of the unit to match the desired pitch attitude. Once in pitch holding mode, the pitch roller knob can be scrolled to select the desired aircraft pitch.

The main drawback of this system is that the pitch must be continuously adjusted during long climbs to ensure that an appropriate airspeed is maintained. Failing to do so may result in dangerously low airspeeds when climbing into higher altitudes. Pressing and holding the control wheel steering (CWS) button on either control yoke allows the pilot to adjust the pitch of the aircraft without fighting the autopilot servos, or using the pitch roller knob. Upon releasing the CWS button, the aircraft will resynchronize the pitch roller knob, and begin holding the new pitch attitude selected by the pilot.

When the aircraft's pitch is controlled by glideslope mode, activating attitude mode can cause the aircraft to pitch down unexpectedly if the pitch knob has been left in a nose down position. For this reason, the "ATT" lamp will flash when these two conditions are met.

This aircraft is equipped with an auxiliary autopilot mode annunciator panel on the pilot's main instrument panel, above the attitude indicator. This unit mirrors the autopilot mode annunciation on the mode control panel.

NOTE: For your convenience, the autopilot mode annunciator panel can be used to toggle autopilot modes without needing to look down at the pedestal.

The flight director on the Century 1U367 Steering Attitude Indicator can be activated and deactivated by turning the knob at the bottom left of the instrumet's bezel, marked "FD". The flight director can also be deactivated via the red autopilot disconnect buttons on either yoke. In the real aircraft, this push button has two stages of activation. For your convenience, this feature is approximated with two presses of the button. The first press will deactivate only the autopilot master, allowing the user to hand-fly the aircraft. The flight director and relevant modes will remain engaged. Upon pressing the disconnect button a second time, the flight director will also be disengaged. When the autopilot master is disengaged after the first press, all autopilot modes can still be selected on the Century IV mode control panel, which will apply to the command bars, just as if the autopilot was still flying the aircraft itself.

Collins PRE-80C Altitude Preselector

Like many autopilots, the Turbine Duke's Century IV receives altitude commands from an adjustment knob and a "pre-selector", which commands altitudes at which to level-out, or hold. The PRE-80C has a three-drum altitude indication, which is mechanically controlled via a knob on the unit's face. The knob controls the thousands digit (with rollover) when pressed in, and the hundreds digit when pulled out. The PRE-80C has an integrated "ALT ALERT" push button and indicator which is a latching-type indicator. The button illuminates when within 1,000 ft of the desired altitude, and when leaving 500 ft within the desired altitude. The alert can be canceled by pressing the PRE-80C's integrated push button. When the unit is not receiving power, or not connected to the Century IV autopilot, a red flag appears across all digits.

ETM Engine Trend Monitor

This engine trend monitor is a powerful tool for monitoring turbine engines and aircraft performance, and should be used to its fullest potential to prevent engine damage, increase mechanical longevity, and provide the most efficient cruise flight. See the standalone section of this manual for instructions on using the ETM, below.

Bendix RDR 1150XL Color Weather Radar

This implementation of the Bendix RDR 1150XL has six selectable modes via the mode select knob in the upper right-hand corner of the unit. When cycled through the "OFF" mode, the unit will perform a self-test upon startup, and will annunciate if signal is not received from the aircraft's external weather radar transceiver unit.

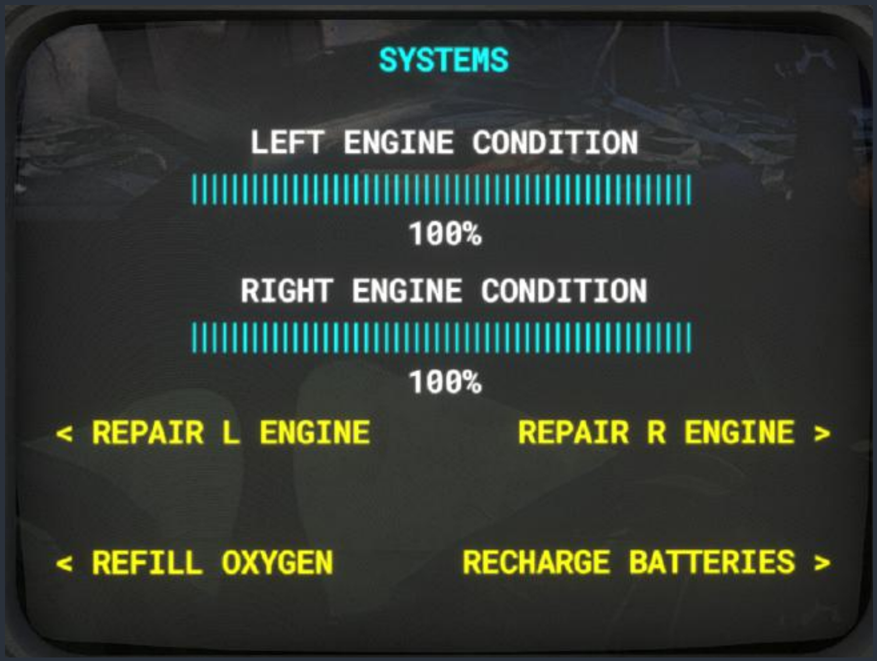
In "STBY" mode, the unit is in a safe standby mode, which does not energize the radar transmitter. It is recommended that the unit be placed in standby mode whenever the aircraft is operating on the ground to avoid injuring ground personnel, or sensitive equipment on other nearby aircraft. In this mode, the unit will annunciate "STAND BY" in yellow in the center of the radar arc.

In “TST” mode, the unit will continuously display a sweeping test signal from the radar unit, which should subtend the full horizontal radar arc, and contain concentric arcs of magenta, red, yellow and green. The “RT FAILURE” flag will also display in cyan.

The “ON” mode is the normal mode of operation for this unit. In “ON” mode, the radar will display precipitation and severe turbulence in the above color spectrum, within the radar arc on the screen. The range of the display can be adjusted with the “RNG ^”, and the “RNG v” push buttons. Nautical mile distances are displayed adjacent to the range rings on the radar display. By pressing the “VP” button, the unit can be toggled between horizontal and vertical profile modes, which are annunciated in the upper left-hand corner of the display. The “<TK” and “TK>” buttons can be used to pan the radar transceiver to the right or left, and the “TILT” knob can be used to tilt the radar transceiver up or down. The position of the radar transceiver is annunciated on the display in yellow, but there is no effect on the underlying weather radar simulation. Lastly, “BRT”, and “GAIN” knobs on the left of the unit can be used to control the brightness and gain of the radar respectively. “NAV” and “LOG” modes are not implemented yet in this unit. This unit’s state will be saved automatically and reloaded.

This aircraft is equipped with an underlying software system that is capable of triggering a failure of almost any simulated aircraft system, either determined by the Mean Time Between Failure (MTBF) of each component, or at a scheduled time. Failures are configured via the tablet interface, discussed in the “Tablet Interface” section of this manual. The “NAV” and “LOG” pages of this weather radar interface have been replaced with quick access shortcuts for accessing the failure and engine condition options in this aircraft.

On the NAV page, you will be presented with a segmented bar graph indicating the current engine condition. Using the keys on the weather radar bezel indicated by the YELLOW text and accompanying arrows, you can reset engine conditions to 100% and restore all of their components to working order, refill the oxygen cylinder, or recharge the batteries.



On the LOG page, you will be presented with the current number of active failures. This can be useful if you wish to be alerted of new failures without having the tablet interface open, since the weather radar sits just within the forward view of the pilot. Pressing the corresponding button on the weather radar's bezel to reset all failures, will reset all the currently active failures.

Garmin GTX 327 Transponder

The GTX 327 transponder supports the typical transponder modes of operation; off, standby, on, and altitude reporting mode. This transponder also has a VFR preset button, which will automatically set the transponder code to your region's VFR flight code (such as 1200 in the United States). The unit is also equipped with an ident button for responding to ident requests from air traffic control. Pressing the "FUNC" button will cycle through the unit's function modes, which are as follows:

1. Pressure Altitude (in flight levels)
2. Flight Timer (triggered by weight-on-wheels sensor)
3. Outside Air Temperature & Density Altitude
4. Count Up Timer
5. Count Down Timer

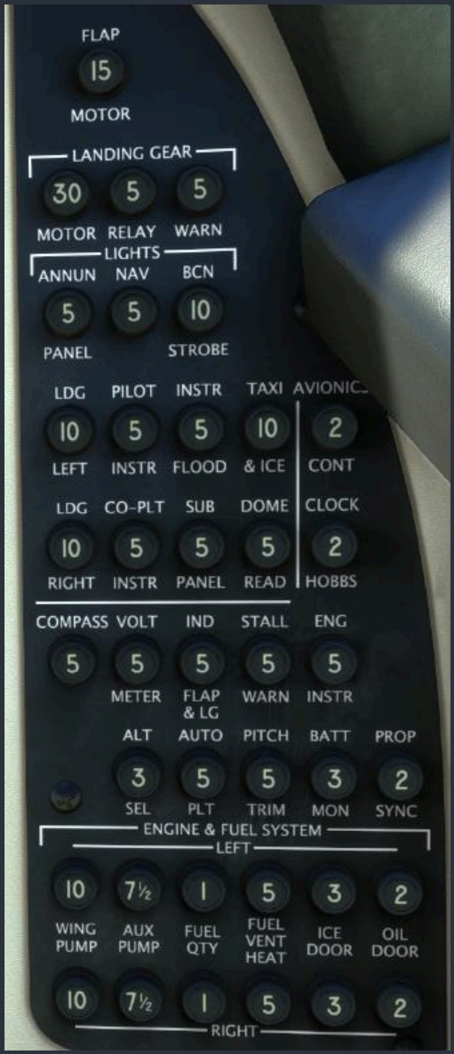
Timers can started and stopped by pressing the "START/STOP" button, and the time can be cleared/reset with the "CLR" button.

Electrical/Miscellaneous

Circuit Breakers

The Turbine Duke's circuit breaker panels are located on the copilot's side of the aircraft. Power distribution and high load breakers are located on the copilot's right subpanel. Avionics circuit breakers are located on the copilot's lower side panel. All other circuit breakers are located on the copilot's upper side panel. The avionics circuit breaker panel consists of four rows. The first and third rows from the top receive power from the left distribution bus through the left avionics bus relay. The second and fourth rows from the top receive power from the left distribution bus through the right avionics bus relay. For more information on these breakers, see the electrical schematics included in this manual.

Breakers may be pulled or pushed to disable electrical circuits and bus connections within the aircraft. All the corresponding electrical circuits are modeled. The status of the electrical system may be monitored via the volt and amp meters discussed below. In an emergency situation, such as the detection of smoke, acrid burning smells, loss of engine, or alternator failure, all non-essential electrical systems should be switched off, workload permitting. For load shedding purposes, one of the two avionics bus relay circuits on the copilot's right subpanel can be pulled to disable half of the avionics equipment.



Voltmeter & Ammeters

On the center subpanel, six digital 7-segment displays indicate various electrical parameters of the aircraft. The two top meters are loadmeters, indicating generator load in amps. The middle two meters indicate the voltage sensed at the left and right distribution buses. The bottom two meters indicate the current supplied to each propeller hub and inlet for deicing in amps. When both engines are running at the same RPM, the loadmeters should read very similarly. Should they become different, it could indicate a failed generator, failed voltage regulator, or an overvoltage or overcurrent condition that has triggered a generator bus isolation..

An additional horizontal meter on the pilot's left subpanel, marked "WSHLD DE-ICE AC VOLTS" indicates the alternating current voltage supplied by the left windshield and standby avionics AC inverter. This meter contains a green band between 220 and 260 volts, and should be monitored while windshield heat is in use, as windshield heating cycling is powered by a temperature controlling unit.

NOTE: The windshield heat switch must be on to activate the windshield and standby avionics AC inverter for use as an alternate source of AC avionics power.

Instrument Air Indicator

The instrument air indicator shows the regulated air pressure generated by the two engine-driven air pumps. The scale on the gauge indicates the acceptable pressure range through the aircraft's cruising altitudes. At sea level, the vacuum suction should be near the top of the green arc, above 5 inHg. Since dual engine failure in a twin engine aircraft is very unlikely, there is no additional electric standby instrument air pump. At the bottom of the gauge, there are two red incandescent indicator bulbs to indicate when a source of instrument air has become inoperable. These indications should be checked during engine starting.

Deicing Boot Pressure Indicator

Deicing pressure for the aircraft's inflatable deicing boots is supplied by a mechanical instrument air pump on each engine. This is the same air source used to power the gyroscopic flight instruments. This gauge indicates the pressure in PSI being admitted to the deicing boots, and will cycle as the automatic deicing boot controller cycles the pressurized air to the different zones of the aircraft. The pressure will be a few PSI less when operating the deicing boots in manual mode, as this activates all deicing zones at once.

Oxygen Pressure Gauge

On the pilot's side wall, a gauge indicates the oxygen pressure available in the onboard, refillable oxygen cylinder. This cylinder is normally pressurized to 1,800 - 2,000 PSI when serviced on the ground. Oxygen pressure will deplete as it is consumed by passengers and crew, when activated. To activate the built-in demand-type oxygen regulators for all occupants, rotate the brushed metal oxygen supply knob on the pilot's side wall counterclockwise until the green marking is visible. Oxygen will be consumed by the occupants only in accordance with the current pressure altitude of the aircraft, and the weights of the crew members. The oxygen pressure is saved between flights, and can be refilled via the payload screen of the tablet interface, or the "SYSTEMS" page on the weather radar. When the cabin oxygen system is activated, the sound of pressurized gas flowing through pipes will be audible.

Yoke-Mounted Digital Chronometers

On each yoke, there is a digital chronometer capable of displaying two different clock modes, and one timer mode, cycled through with the "SELECT" push button. The two clock modes are Universal Time ("UT"), and Local Time ("LT"), each in 24-hour format. The Elapsed Time ("ET") mode is a count-up stopwatch, controlled via the "CONTROL" push button. The maximum displayable time in Elapsed Time mode is 99 minutes and 59 seconds. The mode of these chronometers will be automatically saved and restored at the beginning of a new flight.

Tach Timers

The included Hobbs timers on the pilot's lower subpanel run at a speed proportional to the engine's current RPM over its cruising RPM, indicated in tenths of an hour.

Carbon Monoxide Detector

At the top right of the copilot's main panel, is a carbon monoxide detector. Carbon monoxide is a potentially deadly gas that results from the combustion of hydrocarbons, such as in an aircraft's turbine engine. The gas is odorless, and colorless, making it extremely difficult to detect. To test this carbon monoxide detector, depress the "TEST/RESET" button on the unit. Both the amber and green "ALERT" and "STATUS" lights should illuminate. The detector is battery operated, and the green status light should blink once every few seconds to indicate that the unit is functioning properly. The detector can both fail, and detect an exhaust gas leak via the integrated failures system. If carbon monoxide is detected, a warning tone will sound, and action should be taken immediately. The source of the leak is indicated on the cabin climate visualizer in the tablet interface by the presence of a gray gradient in the air ducts.

Cabin Pressurization System

The cabin pressurization is controlled via the controls and instruments on the co-pilots left subpanel. The selector dial consists of two offset control knobs. The small knob at the bottom left controls the cabin climb/descent rate from between approximately 150 ft/min to 2,000 ft/min. A position approximately one third of the knob's full rotation from the counterclockwise stop should produce a desirable climb rate of around 700 ft/min. The larger, centrally located knob controls the destination cabin altitude by rotating a scale visible through the plastic window above the knob.

The upper scale of this rotating card (labeled “CABIN”) is used to set the desired cabin altitude from -1,000 ft to 15,000 ft. The lower scale (labeled “ACFT”) rotates with the upper scale and depicts the approximate aircraft pressure altitude at which the pressurization controller will no longer be able to maintain the desired cabin pressure. For example, when the upper scale is set to 8,000 ft at the small black index mark on the plastic window, the inner scale will read approximately 19,900 ft at the same black index mark. This means that the pressurization controller will be able to maintain a cabin pressure equivalent to 8,000 feet pressure altitude until the aircraft reaches 19,900 feet pressure altitude. If the aircraft continues climbing without an adjustment being made to the pressurization controller, the cabin altitude will begin climbing beyond the desired 8,000 feet. If the cabin pressure differential becomes negative, or increases beyond 4.7 psi, the electric dump valve will activate, rapidly dropping the pressure differential. The electric dump valve can be disabled by pulling the “PRESS CONT” circuit breaker on the power distribution circuit breaker panel.

To the right of the cabin pressurization controller dial and instruments is a three position locking toggle switch. The center position of the switch, labeled “NOR”, is for normal operation, and allows the cabin to be pressurized as soon as the aircraft leaves the ground. The “DUMP” position manually triggers the electrically actuated pressurization dump valve to rapidly release pressure. Dumping the cabin pressure can be painful for passengers and crew. This switch position should only be used during an emergency, or to ensure that the cabin pressure is equalized with the ambient pressure before opening doors and windows. Given that all manner of failures are possible in Black Square aircraft, be sure to verify the cabin pressure differential is near zero before placing the switch in the dump position once on the ground. Placing the switch in the “TEST” test position will bypass the weight-on-wheels sensor, allowing the cabin to pressurize while on the ground, which is required for the pressurization ground checks.

On the copilot's right subpanel are two red pull handles labeled "PRESSURIZATION AIR PULL TO SHUT-OFF". Unlike a normally aspirated aircraft, which derives breathing only from the ambient air, and unlike a pressurized reciprocating engine aircraft that uses regulated air from each turbocharger, a turbine engine aircraft uses regulated bleed air to pressurize the cabin. In the event of a fire, carbon monoxide leak, or other hazardous condition, it may become necessary to isolate an engine from the breathable air in the cabin by pulling these handles away from the instrument panel. They can also be used to test the pressurization supply air of each engine during the ground pressurization test, to ensure both are functional. In the Turbine Duke, hot bleed air from the engines is vented into the engine nacelles whenever the red shutoff handles are pulled. Prolonged operation with the engine running and this handled pulled should be avoided to prevent equipment damage.

Opening the cabin door or cockpit storm window will rapidly decompress the aircraft. Due to the force of the pressurized air on the inside of the cabin, opening the storm window is impossible at normal operating altitudes and pressures, because the door opens inwards. The main cabin door, on the other hand, opens outwards. For this reason, the door is equipped with a simple pressure differential sensing mechanism, which prevents occupants from opening the door while the aircraft is pressurized even a few tenths of a PSI. Should this mechanism become defective, or to enable emergency egress, pulling the red T-handle on the door will defeat the pressurization lockout mechanism.

NOTE: Unlike a reciprocating engine aircraft, a full throttle reduction in flight is unlikely to compromise cabin pressurization in a turbine engine aircraft, as the gas generator stage of the engine is always producing sufficient airflow to keep the engine running. If the engines are shut down or bleed air is shut off with the red pull handles, check valves will prevent the rapid depressurization of the cabin, but leaks in the system will allow pressurized air to escape that cannot be replaced.

Approximate duration of useful consciousness following a cabin depressurization event:

30,000 ft MSL - 1 to 2 minutes
28,000 ft MSL - 2-1/2 to 3 minutes
25,000 ft MSL - 3 to 5 minutes
22,000 ft MSL - 5 to 10 minutes
18,000 ft MSL - greater than 30 minutes

Feather Warning System

Unlike many turbine engine aircraft, the Turbine Duke is not equipped with autofeather. This means that the pilot is responsible for feathering the propeller of an inoperative engine after failure, even during times of extreme workload. In some conditions, the aircraft may not maintain a positive rate of climb with a windmilling engine immediately after takeoff, especially during high density altitude operations. For this reason, the aircraft is equipped with a feather warning system to help the pilot identify the failed engine and feather its propeller expeditiously.

The black plastic propeller pitch control knobs of the Piston Duke have been replaced with translucent blue handles with a light inside. Whenever the oil pressure of the associated engine is below operating pressure, the handle is brightly illuminated in blue. This signals the pilot to immediately pull the handle into the fully feathered position.

Fire Detector & Extinguishers

This aircraft is equipped with fire detector loops in each engine nacelle. When temperatures in the nacelle are sufficiently high, the presence of an engine fire is likely, and the red ENG FIRE annunciator lights will illuminate. Simultaneously, a red FIRE annunciator will illuminate on the fire extinguisher panel, located above the center subpanel. When a fire is suspected, the engine should be shut down following the engine fire checklist, then the covered extinguisher push button should be pressed. This will discharge a one-time use fire suppression bottle within the nacelle, hopefully extinguishing the fire and ending the ENG FIRE warning.

The fire detectors and extinguishers can be tested by pressing the FIRE DET P.T.T. button on the fire detector panel to the left of the annunciator panels. When the button is pressed, the green extinguisher “OK” light should illuminate.

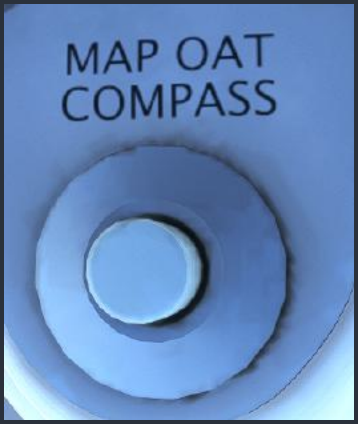
Also located on the fire detector panel are two generator overcurrent lights, labeled “GEN O.C.”. These lights indicate when an overcurrent condition has been detected, and a generator has been isolated from the main distribution bus. The resulting difference in generator bus load can be observed on the digital ammeters, just as with an overvoltage isolation in the Piston Duke.

Lighting Controls

Cabin Lighting

Cabin reading lights for each seating position can be turned on and off via the overhead push buttons over each seat. An additional overhead flood light is included above the flight crew seats for all-around cockpit illumination. Ensure that cabin lighting is turned off during all flight and ground operations, as light bleeds from the cabin into the cockpit area, diminishing the quality of crew night vision. Keep in mind that incandescent, DC, cabin lighting presents a significant drain on the aircraft battery during operation. Use of cabin lighting should be kept to a minimum when the aircraft battery is the only source of electrical power.

Cockpit Lighting



In addition to the overhead cabin lighting, each yoke possesses a “MAP OAT COMPASS” toggling push button of similar style to the overhead cabin light switches. On the pilot’s yoke, this button will control four lights: a stem light to illuminate the outside air temperature gauge, a stem light to illuminate the oxygen pressure gauge, integrated lighting in the magnetic compass, and a map reading light on the underside of the yoke, which is focused at the pilot’s knees. On the copilot side, this switch will only control the yoke-mounted reading light.

Panel Lighting

All instrument panel lighting is controlled via the pilot's right subpanel. A single toggle switch to the left of the lighting dimmers toggles all panel lighting on or off. Eight vertical dimmer knobs control the intensity of various lighting groups. These groups are; left main panel, right main panel, engine instruments, avionics and audio panel, red glareshield floodlight, white glareshield floodlight, subpanel electroluminescent integrity lighting and gauges, and pedestal trim indicator lighting and autopilot control panel backlighting. Notably, the Turbine Duke is equipped with red and white glareshield lighting. White glareshield lighting should be used only during flight preparation on the ground, or when proper color vision is necessary to read charts or cockpit instrumentation. At all other times, the red glareshield lighting should be used to best preserve the flight crew's night vision.

Voltage-Based Light Dimming

Black Square's aircraft now support an advanced dynamic interior and exterior lighting and panel backlighting system that simulates several characteristics of incandescent lighting. Mainly, real world pilots will be intimately familiar with interior lights dimming during engine starting, or becoming brighter when an alternator is switched on. The brightness of the lights in this aircraft are now calculated as the square of the available voltage.

The lights in this aircraft will react to even the smallest changes in the electrical system's load. For example, a generator failure in flight will result in the dimming of lights. Should a second, or standby generator, not provide sufficient power to support the remaining systems on the aircraft, this is signaled by the dimming of lights in response to even small additional loads, such as exterior lighting. The incandescent lights also simulate the dynamics of filaments, creating a noticeably smoother effect to changes in their intensity. This system has the advantage of allowing for easier dimmer setting with L:Vars, and preset configurations when loading the aircraft in different lighting conditions.

State Saving

This aircraft implements “selective” state saving, meaning that not all variables are saved and recalled at the next session, but some important settings are, primarily to enhance the user experience. Of primary interest, the radio configuration is saved, as well as any preset frequencies/distances/radials/etc that are entered into radio memory. Many radio and switch settings are also saved for recall, including cabin environmental controls, and the state of other cabin aesthetics, such as sun visors, armrests, and windows. No action is required by the user to save these configurations, as they are autosaved periodically, or whenever required by the software. The state of switches that affect the primary operation of the aircraft, such as battery switches, de-icing, etc, are not saved, and are instead set when the aircraft is loaded based on the starting position of the aircraft. Engine health and oxygen pressure are saved between flights, and can be reset via the tablet interface, or the “SYSTEMS” screen on the Weather Radar.

Fuel tank levels will be restored from the last flight whenever a flight is loaded with the default fuel levels. Due to a currently missing feature in MSFS, payload and passenger weights cannot be restored in the same method, although the code has been implemented to do so.

Whether or not the engine covers, pitot covers, and wheel chocks are deployed when loading the aircraft on the ground is controlled via the “Load with Covers & Chocks Deployed” option on the tablet’s options page.

Note: Since this aircraft uses the native MSFS state saving library, your changes will only be saved if the simulator is shut down correctly via the “Quit to Desktop” button in the main menu.

Environmental Simulation & Controls

This aircraft is equipped with a simulated environmental control system, allowing the user to learn the essentials of passenger comfort while operating this aircraft. Cabin temperature is calculated distinctly from outside air temperature. Since the walls of the aircraft are insulated, it will take time for the cabin temperature of the aircraft to equalize with the outside air temperature. The cabin will also heat itself beyond the outside air temperature during warm sunny conditions, and slowly equalize with the outside air temperature after sunset. The cabin climate controls are located on the copilot's left subpanel.

Without the need for any aircraft power, the cabin temperature can be partially equalized with the outside air temperature by opening the pilot's side storm window or the cabin door, and fully equalized by ram air cooling, so long as the airspeed of the aircraft is great enough. Cabin temperature can also be equalized with the use of the electric vent blower centrifugal fan mounted in the tail of the aircraft. The rate at which temperature equalization, active heating, or active cooling can be achieved can be increased by placing the "VENT BLOWER" switch in the "HI" position when the climate control system is in use.

Cabin Temperature Monitoring

A temperature monitoring system is available in this aircraft to monitor cabin temperature, and alert the pilot to when cabin temperatures have become unacceptably hot or cold. The digital LCD temperature display, located above the copilot's airspeed indicator, will display temperatures from -99° to 999° Celsius, or Fahrenheit, toggleable with the small blue push button. In addition to this LCD display, two small LED's are located above the digital engine instrumentation to indicate when cabin temperatures are unacceptably hot or cold within the pilot's primary field of view, and call their attention to the cabin temperature settings. The "CABIN TEMP LOW" light illuminates when cabin temperatures are below approximately 50°F, or 10°C. The "CABIN TEMP HIGH" light illuminates when cabin temperatures are above approximately 90°F, or 32°C. Both lights will flash rapidly when the cabin pressurization altitude exceeds approximately 15,000 ft without supplemental oxygen to indicate a hypoxic cabin.

NOTE: The entirety of the cabin climate state can also be inspected via the cabin page of the tablet interface. For more information on the tablet's cabin page, see the "Cabin Climate Visualizer Page" section of this manual.

Cabin Environmental Controls

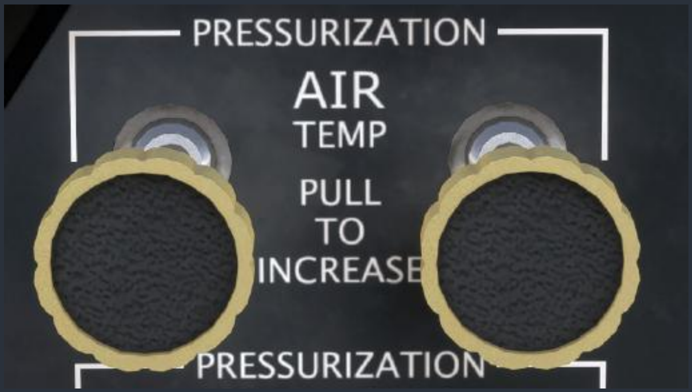
The climate control system is activated by rotating the “CABIN TEMP MODE” knob to any position other than the two “OFF” positions. Either “BLOWER” position can be used to equalize the cabin temperature with the outside ambient temperature. In “MANUAL HEAT” or “MANUAL COOL” modes, the system will apply the maximum available heating or cooling to the cabin ventilation air. In “AUTO HEAT” or “AUTO COOL” modes, the system will monitor the cabin vent temperature and appropriately mix the incoming air to produce the desired temperature. The desired temperature is set with the “CABIN TEMP” knob to the right of the vent blower switch. Desired temperature can range from approximately 50°F (10°C) to 100°F (38°C).

NOTE: The heating and cooling modes will only EITHER heat or cool the cabin, not both. This requires the operator to switch from heating to cooling when the desired cabin temperature is below the outside air temperature, or from cooling to heating when the desired cabin temperature is above the outside air temperature.

Unlike the Piston Duke, cabin heating in the Turbine Duke is supplied by hot bleed air from the turbine engines. The original combustion heater of the Piston Duke remains installed, but rendered inoperative, as the heater is not approved for operation with jet fuels instead of aviation gasoline. Unfortunately, this means that at least one engine must be running in order to heat the cabin.

NOTE: A combustion heater is a gasoline powered furnace, and a notoriously dangerous piece of aircraft equipment. While the Turbine Duke may be less comfortable during ground operations in cold environments, the aircraft is undoubtedly safer without the combustion heater.

Since the Turbine Duke has a service ceiling of 30,000 ft, outside ambient air temperatures can be as low as -80°F (-60°C) in the extreme latitudes. This 150°F (80°C) temperature differential between the intake air and a comfortable cabin temperature requires enough hot bleed air to overheat the ducts in the cabin. For this reason, the Piston Duke's two pull handles, labeled "PRESSURIZATION AIR TEMP PULL TO INCREASE" above the red pressurization air shutoff handles, have been repurposed. When these handles are pulled, additional hot bleed air is admitted to the cabin heating system. When operating at very low outside air temperatures (10°F (-12°C) or below), the air handles should be progressively pulled away from the panel to achieve the desired cabin temperature. The handles should be returned to their closed (pushed) positions whenever not required for maximum bleed air heating to avoid melting the cabin air heating ducts.



Four pull handles on the subpanels are used to direct the flow of ventilation air around the aircraft's interior. The "PILOT AIR" and "COPILOT AIR" are both pull-off type handles, meaning that maximum airflow is provided by default when the handles are pushed towards the panel. The "CABIN AIR" and "DE-FROST AIR" are pull-on type handles, meaning that maximum airflow is not provided by default when the handles are pushed towards the panel. Increasing airflow by adjusting the first three of these handles can be used to augment the equalization rate of the climate control system. While the Turbine Duke is equipped with deicing boots and a heated windshield, the windshield can be partially deiced using hot environmental air in the event of a heated windshield or secondary AC inverter failure. The "DE-FROST AIR" handle must be pulled away from the panel, the environmental control system must be operating in one of the two heating modes, and bleed air must be available.

Air Conditioning Condenser Scoop

The Turbine Duke is equipped with an electromechanically actuated air conditioning condenser scoop system on the top of the right engine nacelle. When the air conditioner is not in use, the door is fully stowed to minimize drag. When the air conditioner is used in flight, the door is only partially extended. When the air conditioner is activated and the landing gear is extended, the condenser door is fully opened to provide better cooling during ground operations. The air conditioner should be turned off and the door retracted before takeoff to ensure maximum climb performance. The additional drag produced by the air conditioner condenser scoop will rob the aircraft of several knots when in cruise flight, but could produce as much as 10 knots worth of drag should the door become stuck in the fully extended position during flight.

Left: fully extended - ground position   Right: partially extended - flight position

Air Conditioning Temperature Effects

When the air conditioner is operating, the load is increased on the right engine’s accessory gearbox. The load is proportional to the differential between the outside air temperature and the desired cabin temperature. This increased load on the engine can cause internal temperatures to increase. The temperature increase is proportional to the airflow through the engine nacelle, which is influenced by the condenser scoop’s position. Particularly while operating on the ground, the operator should keep an eye on engine temperatures. Since the condenser door can become stuck in this aircraft simulation, a fully closed condenser door on the ground could cause dangerously high engine temperatures. During low airspeed climbs or while operating at low altitudes, the additional cooling required in the right engine may send interstage turbine temperatures and oil temperatures into a dangerous regime if not properly managed. This may require the prolonged use of the oil cooler door on the right engine to keep temperatures within limits. Increased ITT in the right engine may require a reduction of power during climbs to observe ITT limits.

Turboprop Engine Operation

The turbine engine simulation in this aircraft is significantly more complex than most employed in flight simulators, especially as it pertains to engine starting. Improper starting technique can destroy an engine within seconds. The engines installed in the Turbine Duke can also suffer from overheating oil, if not managed properly.

NOTE: The entirety of this complex engine simulation can be monitored via the engine pages of the tablet interface. For more information on the tablet's engine pages, see the "Engine Visualizer Page" section of this manual.

Condition Levers

Unlike most PT6 turboprop engine installations, the Turbine Duke does not have low-idle and high-idle positions for its condition levers. The Turbine Duke's fuel condition lever positions are labeled "RUN" and "CUT-OFF". To avoid hot starts, the condition levers should not be moved to the "RUN" position before the gas generator reaches maximum RPM via the electric starter motors. For more information on starting see the Starting Temperature, Residual Heat & Dry Motoring section, below.

Turbine Engine Ignition

Turboprop engines are equipped with a continuous ignition system that can be toggled on and off manually, or automatically with a rocker switch on the pilot's upper side panel. In the "ON" position, the igniters arc continuously. This position should be used during starting, and during extreme weather conditions to prevent engine flameout. In the "AUTO" position the igniters will only be energized when the torque of the associated engine falls below approximately 250 FT-LBS. The automatic position should be used whenever the inertial separators are required, during moderate and severe turbulence, and when operating at high altitudes at night.

Fuel Pumps

The Turbine Duke has two electric fuel pumps per engine, controlled via rocker switches on the pilot's upper side panel. The "Wing Pump" is a submerged wet pump, operating within the fuel tanks, at the lowest point in the fuel system. The "Aux Pump" is an in-line pump operating within the engine nacelle. The fuel system is designed to only have one fuel pump per engine operating at a time. During crossfeeding operations, the auxiliary pump of the engine receiving the crossfeed must be disabled to avoid a fuel overpressure. All four fuel pumps must be functional for takeoff.

Turbine Engine Fuel Control Failures

This aircraft implements two types of partial engine failures that are unique to turbine engines. The first is a fuel control failure, resulting in the engine's power lever having minimal or zero control over the engine's fuel flow. This failure can occur during any phase of flight. In the case of the Turbine Duke, this failure may necessitate an engine shutdown, as there is no auxiliary fuel control system, unlike some other turboprop aircraft.

The second type of failure is engine compressor surging. Turboprop engine surging is the result of disrupted airflow to the engine, and manifests as unstable gas generator RPM, or sudden changes in engine performance. This may occur as the result of severe turbulence, ingestion of large debris (such as birds), or catastrophic failure of internal engine components. At the first indication of compressor stall or surging, engine power should be reduced, and continuous ignition activated to prevent flameout. The surging will be less severe when power is reduced, but the flight should only be continued to the nearest practical field for landing.

Inertial Separators (Ice Deflectors)

Most turboprop engines possess a method of separating particulate from engine induction air by method of repositioning louvers within the engine air intake. These louvers can be inspected from the exterior of the aircraft. When operating normally, incoming air takes a direct path to the PT6's internal radial intake. When the inertial separator (sometimes called an ice deflector, or simply "bypass") is activated, the airflow must take a sharp turn, which ejects particulate through a large vent at the bottom of the engine. The inertial separators have the disadvantage of reducing free airflow to the engine, thus reducing maximum torque, or torque available at for a given ITT for a given set of conditions. This is the first aircraft for MSFS that simulates damage from foreign objects caused by operation on unimproved surfaces. For more information, see the "Foreign Object Debris Damage" section of this manual.

The inertial separators are controlled via switches located on the pilot's lower side panel, labeled "ICE DEFLECT". The inertial separators should be used whenever operating on unimproved or marginal surfaces, and whenever entering visible moisture. It takes 15-20 seconds for the inertial separator louvers to reposition, so anticipation of sky conditions as far as five miles ahead of the aircraft may be required to ensure proper use.

Oil Cooler Doors

An electromechanically actuated door within the engine nacelle is used to vary the amount of airflow over the oil cooler radiator. These actuators are controlled via switches located on the pilot's lower side panel, labeled "OIL DOOR". The oil cooler door positions are indicated on the annunciator panel. The doors should be opened for takeoff and landing, and closed for cruise flight. When operating at lower airspeeds with the air conditioner operating, it may be necessary to leave the oil door open on the right engine for longer than normal, especially on particularly hot days, to keep the oil temperature within limits.

Propeller Governors

The propeller governor is an essential component of a high performance aircraft that controls the pitch of the propeller blades, usually by metering oil pressure to the propeller hub. In multi-engine aircraft, the propeller blade pitch system is usually configured to automatically feather the propellers when oil pressure is lost. For this reason, an increase in indicated oil pressure is expected while exercising propeller pitch on the ground. To ensure that these systems are functioning properly, governor test buttons are provided for use during the runup procedures. Holding the button will offset the overspeed propeller governor to a lower RPM, limiting the propeller to around 2000 RPM. Should the governor fail to maintain the expected RPM in flight, or on the ground, the flight should be discontinued as soon as practical.

Starting Temperature, Residual Heat & Dry Motoring

The rate at which heat is dissipated or accumulates in the combustion chamber of a turboprop engine is largely determined by the rate of airflow through the engine. When the engine is not self-sustaining combustion, this airflow is created by the gas generator, or the wind flowing around the aircraft.

During starting, it is essential to allow the gas generator to reach its maximum attainable RPM while operating on the starter motor before introducing fuel to the engine. This will keep engine starting temperatures to a minimum. The rate of airflow during starting is also influenced by the apparent wind around the engine nacelles. Facing the aircraft into the wind before starting will help keep temperatures low, but starting with a significant tailwind opposing the exhaust flow can lead to excessively hot starts.

After shutdown, ITT may remain sufficiently hot as to preclude a safe engine start without exceeding upper temperature limits. This limitation may present itself during quick turnarounds in high ambient temperatures with little wind to provide passive cooling. In this situation, the engine can be dry motored to reduce temperatures to safe levels before attempting a start. Should the ITT remain above around 150°C, cranking the engine with the electric starter motor will promote airflow through the compressor section, more quickly cooling the engine. Repositioning the aircraft into the wind will also help cool the engine before attempting a restart.

P2.5 Bleed Air Valves

The P2.5 Bleed Air valves are a feature of the PT6A engine, which stabilize the engine at lower power settings by allowing excess air to escape from the gas generator section of the engine, thus reducing the amount that makes its way into the combustion chamber. Both valves are operated by the pressure differential between the higher pressure P3, and lower pressure P2.5 compressor air. When the engine is not running, the valves rest in the open position. The low pressure P2.5 bleed valve closes around 68% Ng, while the high pressure P2.5 bleed valve closes around 92% Ng. Both valves can fail, becoming stuck in their open positions. This will prevent the combustion chamber from receiving the air it needs to produce full power. Should aircraft not develop the full power expected on takeoff, but all other indications are normal, a stuck P2.5 bleed air valve should be suspected.

Engine Preheating

Being lightweight and designed to operate at high temperatures, aircraft engines are more susceptible to damage when started very cold than other engines. This aircraft simulation is equipped with a propane powered heater to preheat the engine before starting. The heater is deployed from the “Exterior Elements” menu on the payload page of the tablet interface. Once ignited, the preheater will heat the engine and its components to around 60-70°F (~35°C) above the ambient temperature in around 10 minutes.

Turbine engines generally don’t require preheating, but doing so will increase engine component longevity, and counterintuitively, provide cooler engine starts due to increased gas generator RPM. Due to the high viscosity of the oil, contracted metal components, and the poor performance of batteries in cold weather, the starter motor may be unable to reach the recommended minimum 15% Ng when ambient temperatures approach -40°F (-40°C) without preheating.

External Power

Aircraft batteries are sized much smaller for their application than automotive batteries to save on weight. Running all the aircraft systems on the ground will be enough to drain the battery completely in 20-30 minutes. Starting in cold weather can also prove difficult, as batteries will provide less current with a greater voltage drop in cold conditions. For this reason, this simulation is equipped with an external battery cart. The cart is capable of supplying many times the capacity of the aircraft’s onboard batteries, with almost no voltage drop due to high instantaneous loads while starting the aircraft. The external power cart is deployed from the “Exterior Elements” menu on the payload page of the tablet interface.

Engine Power Settings

Shaded areas denote operation at max. torque or max. ITT. **All figures at max. gross weight.**

Take-Off Power 100% Torque - Standard Day (ISA) No Wind

Press. Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH/Eng)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	1,260	2,190	58	821	1,003	2,650
2,500	1,260	2,190	56	993	1,122	2,600
5,000	1,260	2,190	54	1,140	1,310	2,550
7,500	1,260	2,190	52	1,256	1,463	2,480
10,000	1,260	2,190	50	1,400	1,648	2,400

Maximum Continuous Power (or limit) - Standard Day (ISA)

Pressure Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH / Eng)	True Airspeed	Range (nm)
SL	940	2,190	47	200	550
10,000	1,100	2,190	44	230	580
20,000	1,150	2,190	45	268	735
25,000	1,010	2,190	40	292	835
28,000	910	2,190	36	290	920

Normal Cruise Power (or limit) - Standard Day (ISA)

Pressure Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH / Eng)	True Airspeed	Range (nm)
SL	1,030	2,000	43	200	560
10,000	1,130	2,000	42	231	620
20,000	1,160	2,000	45	264	675
25,000	1,020	2,000	40	287	765
28,000	920	2,000	34	284	840

Economy Cruise Power (or limit) - Standard Day (ISA)

Pressure Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH / Eng)	True Airspeed	Range (nm)
SL	950	1,800	33	190	570
10,000	1,080	1,800	36	218	655
20,000	920	1,800	31	251	900
25,000	880	1,800	28	254	1,010
28,000	840	1,800	27	263	995

Maximum Range Power - Standard Day (ISA)

Pressure Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH / Eng)	True Airspeed	Range (nm)
SL	750	2,050	32	172	585
10,000	600	2,050	23	176	720
20,000	620	2,050	22	194	1,080
25,000	670	2,050	24	212	1,140
28,000	800	2,050	23	242	1,135

Cruise Climb 95% Torque (or limit) - Standard Day (ISA)

Target Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH / Eng)	Time to Climb (min)	Fuel to Climb (gal)	Dist. to Climb (nm)
5,000	1,200	2,190	57	2	4	5
10,000	1,200	2,190	55	4	7	10
15,000	1,200	2,190	53	6	11	32
20,000	1,150	2,190	50	8	13	37
25,000	1,150	2,190	47	14	22	42
28,000	1,150	2,190	45	20	30	61

Recommended Climb Airspeeds: 120 kts to 20,000 ft, 115 kts to 24,000 ft, 110 kts to 28,000 ft.

Note that the above airspeeds differ from the reciprocating engine version of this aircraft.

Gyroscope Physics Simulation

This aircraft is equipped with the most realistic gyroscope simulation for MSFS yet, which simulates many of the effects real world pilots are intuitively familiar with from their flying.

Most recognizable of these effects is the "warbling" of a gyroscope while it is spinning up, such as after starting the aircraft's engines. This is simulated with a coupled quadrature oscillator, and is not merely an animation. Unlike the default attitude indicators, the attitude indicators in this aircraft are simulated with physics, and their ability to display correct attitude information is dependent on the speed of an underlying gyroscope.

Gyroscope Physics

Gyroscopes function best at the highest possible speeds to maximize inertia. When the gyroscope speed is high, the attitude indicator display will appear to settle rapidly during startup, and is unlikely to stray from the correct roll and pitch, except during the most aggressive flight maneuvers, such as spins. When gyroscope speed is slower than optimal, precession of the gyroscope may cause the display to warble about the correct reading, before eventually settling out on the correct reading, if unperturbed. When gyroscope speed is slow, and well below operating speeds, the forces imparted on it by its pendulous vanes, which usually keep the gyroscope upright without the need for caging, can be enough to prevent the gyroscope from ever settling. Gyroscope speeds generally increase to operating speed quickly (within a few seconds), whether electric or pneumatic, but will decrease speed very slowly (10-20 minutes to fully stop spinning).

When these effects are combined, a failed gyroscope may go unnoticed for several minutes while performance degrades. So long as torque is not applied to the gyroscope by maneuvering the aircraft, or turbulence, the attitude display will remain upright. Either when the gyroscope speed gets very low, or when small torques are applied in flight, the display will begin to tumble uncontrollably. This can be extremely jarring to a pilot during instrument flight, especially if the condition goes unnoticed until a maneuver is initiated.

NOTE: All of the above effects are simulated in this aircraft, and both total and partial gyroscope failures are possible.

Pneumatic Gyroscopes

Pneumatic gyroscopes are powered by either positive ("Instrument Air") or negative ("Vacuum Suction") air pressure in aircraft. The earliest aircraft attitude gyroscopes were powered by venturi suction generators on the exterior of the aircraft, as this did not require the aircraft to have an electrical system to operate. Later, vacuum pumps, or sometimes positive pressure pumps, were added to the engine's accessory gearbox to reduce drag on the exterior of the aircraft, and also to supply air to the instruments before takeoff. With a pneumatic instrument air system, the dynamics of an air pump compound the dynamics of the gyroscope itself.

The speed of a pneumatic gyroscope is controlled by the air pressure (positive or negative) available to it from the source (usually a pump in modern aircraft). The pressure the pump can generate is directly proportional to engine shaft RPM. At lower engine RPM, the performance of a gyroscope may noticeably degrade over time. For this reason, some aircraft operators recommend a higher engine idle RPM before takeoff into instrument conditions. This ensures the attitude indicating gyroscopes are spinning as quickly as possible before takeoff. Notable to nighttime and instrument flying, an engine failure means an eventual gyroscope failure. Once the engine is no longer running, the gyroscope performance will begin to degrade for several minutes until it provides no useful information. Some pneumatic attitude indicators are equipped with an “OFF” or “ATT” flag to indicate when gyroscope speed is no longer suitable for use, but many do not.

When a pneumatic pump fails, it is possible for it to experience a complete failure, or a partial failure. A partial failure may cause a slow degradation of gyroscope performance to a level that still provides usable attitude information, but with significant procession and warbling inaccuracies. A complete vacuum failure rarely results in a completely stopped gyroscope and stationary attitude display, however. During a complete failure, there is often a rotating shaft or blade debris in the pneumatic pump housing, and minimal venturi suction effects on a vacuum pump exhaust pipe. These effects may cause the gyroscope to continue tumbling indefinitely while in flight, only coming to a stop when on the ground. This can be distracting during instrument flight, so some pilots prefer to cover up the erroneous information on the attitude display to avoid spatial disorientation.

Electric Gyroscopes

Electrically powered gyroscopes avoid many of the complications of pneumatic powered gyroscopes, but are often only used as backup instrumentation in light aircraft. The internal components of an electric gyroscope often result in a more expensive replacement than an external pneumatic pump, however, and allow for less system redundancy, especially in multi-engine aircraft. A total electrical failure in the aircraft will result in the failure of electric gyroscope information, and often more quickly than a pneumatic gyroscope, due to the additional resistance of the motor windings on the gyroscope. Unlike a pneumatic gyroscope, an electric gyroscope will often settle almost completely after an in flight failure.

Tips on Operation within MSFS

Turboprop Engine Simulation

The aircraft makes use of Black Square's new gas generator and engine temperature simulation, which offers a vast improvement over the default behavior. Along with the new beta range implementation, these systems produce one of the most realistic turboprop simulations in MSFS. Expect realistic hot starts based on numerous environmental factors, accurate ITT and oil temperature behavior that becomes limiting at high altitude, and precise beta operations while taxiing. The gas generator RPM is also influenced by many factors, and follows a more realistic speed curve at different throttle settings.

NOTE: The entirety of this complex engine simulation can be monitored via the engine pages of the tablet interface. For more information on the tablet's engine pages, see the "Engine Visualizer Page" section of this manual.

Engine Limits and Failures

When you operate an engine beyond its limits, damage to the aircraft is accumulated according to the severity of the limit exceedance, and the type of limit exceeded. For instance, exceeding starting ITT limits will destroy an engine in seconds, while a slight exceedance of the maximum governed propeller RPM would not cause an engine failure for quite some time. When engine health is reduced to 25% of its initialized value, the CHIP DETECT annunciator light will illuminate. If engine parameters are not brought back within limits soon, the engine will fail.

NOTE: The "Engine Stress Failure" option must be enabled in the MSFS Assistance menu for the engine to fail completely.

Exceeding the engine starter limitations stated in this manual significantly will permanently disconnect the starter from electrical power. Be aware that the Turbine Duke does not possess an annunciator pertaining to starter motor overheat, so failure may arise unannounced.

Electrical Systems

The native MSFS electrical simulation is greatly improved from previous versions of Flight Simulator, but the underlying equations are unfortunately inaccurate. Users familiar with electrical engineering should keep in mind that the battery has no internal resistance; however, battery charging rate is correctly simulated in this aircraft, meaning that the battery charge rate in amps is proportional to the voltage difference between the aircraft generators and the battery. Battery charging rate should be kept to a minimum whenever possible, and takeoff limits should be observed.

NOTE: The state of the aircraft's electrical system can be monitored via the electrical page of the tablet interface. For more information on the tablet's engine pages, see the "Live Schematic Page" section of this manual.

Battery Temperature

This aircraft is equipped with a realistic battery temperature simulation. The original aircraft shipped with nickel cadmium batteries from the factory, which made it particularly susceptible to battery overheating. The internal resistance of a battery and the contact resistance of the terminals will produce heat when charging or discharging. Battery temperature should be monitored particularly after starting, before takeoff, and in the event of a generator failure. If battery temperatures are rising rapidly and the battery is not disconnected from the power source, or the rate of charging reduced, the battery terminals will become damaged and the battery will not be available for use on the remainder of the flight. High battery charging rates are acceptable after startup while the battery is recharging; however, care should be taken while taxiing to avoid overcharging the battery. For more information on battery temperature, see the "BTI-600 Dual Battery Temperature Monitor" section of this manual.

Deicing and Anti-Icing Systems

Ice accumulation and mitigation has been buggy since the release of MSFS. As of Sim Update 11 (SU11), the underlying variables for airframe, engine, pitot-static, and windshield icing have been verified to be working correctly. Unfortunately, the exterior visual airframe icing may continue to accumulate regardless of attempted ice mitigation. Apart from the visual appearance, this should not affect the performance of the aircraft. Windshields can always be cleared by deicing equipment, thankfully.

The Turbine Duke is equipped with propeller deicing, pitot heat, fuel vent heat, stall warning heat, windshield heat, deicing boots, windshield defrosters, inertial separators, and heated engine air inlets. Electrical anti-icing for the propellers, pitot-static probes, stall warning heat, windshield heat, and fuel vent heat work continuously, and will slowly remove ice from these areas of the aircraft. The engine induction air inlets are heated electrically whenever the propeller heat is activated. On the other hand, emergency window defrosting is provided by the cabin heating system, and requires the following conditions to be met: the "DE-FROST AIR" handle must be pulled away from the panel, the environmental control system must be operating in one of the two heating modes, and bleed air must be available. For more information on the defroster and its associated controls, see the "Environmental Controls" section of this manual.

Lastly, the aircraft is also equipped with deicing boots that use the instrument air supply to inflate, either manually, or automatically, to shed ice from the leading edges of the aircraft. The surface deicing switch may be placed in either the momentary "MAN" position to pressurize all zones of the aircraft's deicing boots at once, or in the "ONE CYCLE" position to automatically cycle deicing pressure around the three dicing boot zones. The deicing pressure gauge should indicate a maximum of around 18 PSI when the system is activated in automatic mode, and 16 PSI when in manual mode.

NOTE: The electric propeller heat is disabled when the aircraft is on the ground. To test the propeller heat during ground operations, the "PROP HEAT GROUND TEST" push button on the pilot's left subpanel must be held down.

Foreign Object Debris Damage

This aircraft simulates damage caused to turbine engines by the ingestion of particulate matter, better known as foreign object debris, or “FOD”. FOD can include dust, sand, gravel, ice, etc., and is typically associated with operating on unimproved runways. The amount of damage caused by the FOD is calculated based on which of the 25 recognizable surface types the aircraft is currently operating on, the thrust of the propeller, and the position of the inertial separator vanes. In order to prevent damage, be sure to use the inertial separators whenever operating on unimproved surfaces, including all ground operations, and whenever ice is present.

NOTE: The quantity and type of FOD encountered, as well as the position and functioning of the inertial separators, can be monitored via the engine pages of the tablet interface. For more information on the tablet’s engine pages, see the “Engine Visualizer Page” section of this manual.

Beta Range

Due to the large static thrust produced by turboprop engines, they are often equipped with a “beta range”. When the power levers are moved over a gate into this range below the normal flight idle position, the propeller pitch is further flattened to reduce thrust. This aids in controlling the aircraft on the ground without causing excessive brake wear.

This aircraft makes use of Black Square’s new beta range implementation, which is designed to provide accurate ground handling for advanced users, while not interfering with the basic functionality for novices. Beta range is incorporated into the bottom 15% of forward throttle input. Users can assign this 0-15% range to their hardware using 3rd party applications, or with physical detents. The remaining throttle input, including reverse, is assigned normally. By default, the beta range will be inaccessible during flight. An optional power lever beta range annunciator has been added to the annunciator panel for those who do not have hardware or software detents for their throttle input. The annunciator is enabled by default, but can be disabled from the options page of the tablet interface.

NOTE: Inadvertent activation of propeller beta range will be prevented anytime the aircraft is airborne, unless the “Unrestricted Beta Range” option is enabled on the options page of the tablet interface. Use of beta range in flight is not permitted by this aircraft’s operating limitations.

Realistic Strobe Light Bounce

Most light aircraft possess a placard somewhere in the cockpit containing the warning, “turn off strobe lights when operating in clouds or low visibility.” While this message may appear a polite suggestion, real world pilots who have ignored this advice will have experienced the disorienting effects of bright strobe lights bouncing off the suspended water particles in surrounding clouds, and back into their cockpit. The strobe lights on Black Square aircraft will now produce this blinding effect while in clouds or reduced visibility. While the disorienting effects are best experienced in VR, photosensitive users should be strongly cautioned against flying into clouds at night with the strobe lights operating. This feature can be disabled via the options page of the tablet interface.

St. Elmo’s Fire & Electrostatic Discharge

When aircraft operate at high speeds within charged areas of the atmosphere, such as around thunderstorms or in clouds of ash, the metal skin of the aircraft can accumulate charge. Normally, this charge is dissipated to the atmosphere slowly through the static discharge wicks located on the trailing edges of the wings and tail. If the charge buildup is very severe during intense storm conditions, a faint purple glow can emanate from sharp objects on the aircraft, including the static wicks. This corona discharge is colloquially called St. Elmo’s Fire, and it may precede more stunning electrostatic discharges across the aircraft.

Corona Discharge (St. Elmo’s Fire), and Electrostatic Discharge

Though often mistakenly referred to as St. Elmo’s Fire, aircraft windshields may rarely experience electrostatic discharges across them in the same extreme weather. These discharges are due to the dissimilar electron affinities of the painted aircraft skin, and the polycarbonate windows installed in most aircraft. As a charge gradient develops between the windshield and the skin, a harmless discharge will take place between the two. No action is required of the pilot should this occur, but the flashes may be disorienting at night.

Third Party Navigation and GPS Systems

There now exist a number of freeware and payware products to enhance or add advanced navigation systems to MSFS. For example, the TDS GTNxi 750/650, the PMS50 GTN 750/650, the Working Title GNS 530/430, and the KLN-90B. Several of these advanced GPS units implement their own autopilot and flight plan managers. They may also require the use of their own special variables to be compatible with an aircraft’s radionavigation equipment. Accommodating all these different products is not trivial. Black Square’s hot-swappable avionics system has compounded the difficulty. While existing Black Square aircraft have required an update to be fully compatible with some of these new products, the Black Square Turbine Duke should be fully compatible with these products upon release. Users should notice only minor interruptions when switching between GPS units, such as waiting for a GPS to reboot, or an uncommanded autopilot disconnect or mode change.

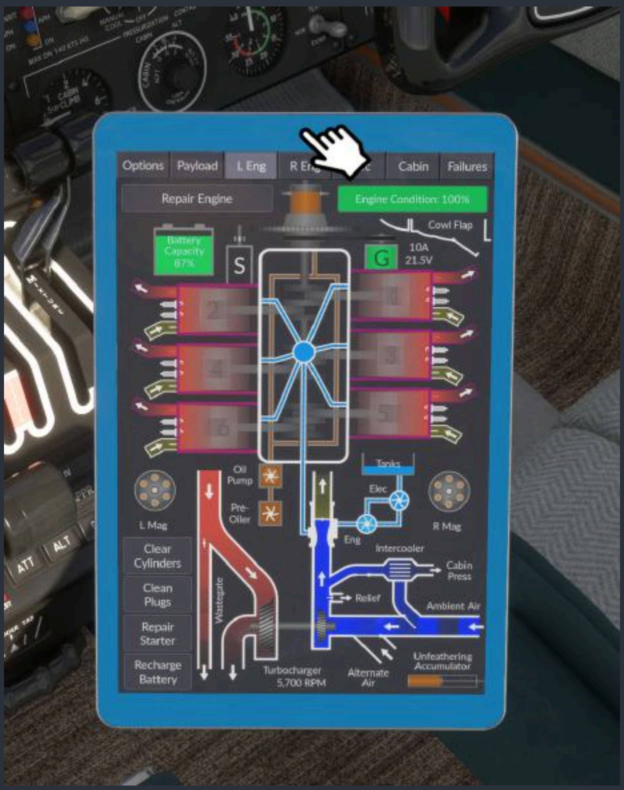
Regarding this specific aircraft, the ETM Engine Trend Monitor includes many more navigation and fuel planning features than the EDM800/760 for reciprocating engine Black Square Aircraft. One of these features has proven difficult to integrate with 3rd party GPS units, because they do not all use the native flight planner. Specifically, Estimated Time of Arrival (ETA) to waypoints and the destination may not possess the correct timezone offset in all conditions. As development continues on these 3rd party products, Black Square will continue to work with the developers to update the fleet, and bring you the most realistic flying experience possible.

Control Locks

Functioning control locks are provided for the pilot's yoke and power levers. The control locks can be removed by clicking on each individually. The control locks are stowed beside the copilot's seat. To access the control locks in their stowed position with a companion occupying the right seat, either just click through the character model, or unload them first via the tablet's payload interface.

Tablet Interface

The Black Square tablet interface is an invaluable resource for the enhanced understanding of complex aircraft systems. The tablet also allows the user to configure all options, manage payload, control failures, monitor engines, electrical schematics, and environmental control systems, all from within the simulator.



To show or hide the tablet, click on the tablet or cabin side wall, beside the pilot's seat. The tablet can be moved around the cockpit by dragging the frame of the tablet.

NOTE: Due to the large amount of information rendered on some pages of the tablet interface, it **may have a noticeable impact on the graphical performance of the simulator on less powerful systems.** This is only a symptom of rendering the graphics, and the rest of the aircraft has been designed to be as frame rate friendly as possible, often outperforming the default aircraft with large glass panel instrumentation. **If you experience this, simply hide the tablet interface when it is not in use, and it will have no further impact on performance.** In testing, the impact of the visualizer has been observed to be **less than 2-3 fps** when open.

Options Page

Your selections on the options page will be saved and restored next time you load the aircraft.

1. Primary Avionics Selection

The primary avionics choice will occupy the role of the COM1 and NAV1 radios. This selection could limit the available choices for secondary and tertiary avionics selections. When a GPS is selected as the primary avionics choice, it will always be the unit driving the pilot's HSI and autopilot. This selection will be saved and recalled at the start of your next flight.

2. Secondary Avionics Selection

The secondary avionics choice will occupy the role of the COM2 and NAV2 radios. This selection could limit the available choices for tertiary avionics selections. When a GPS is selected as the secondary avionics choice, it will only drive the pilot's HSI and autopilot if no GPS is selected as the primary avionics selection, and the capability exists for the secondary choice. For example, a secondary PMS50 GTN 650 or TDS GTNxi 650 will drive the autopilot and pilot's HSI if the KX155 is selected as the primary radio. This selection will be saved and recalled at the start of your next flight.

3. PMS50 GTN / TDS GTNxi Switch

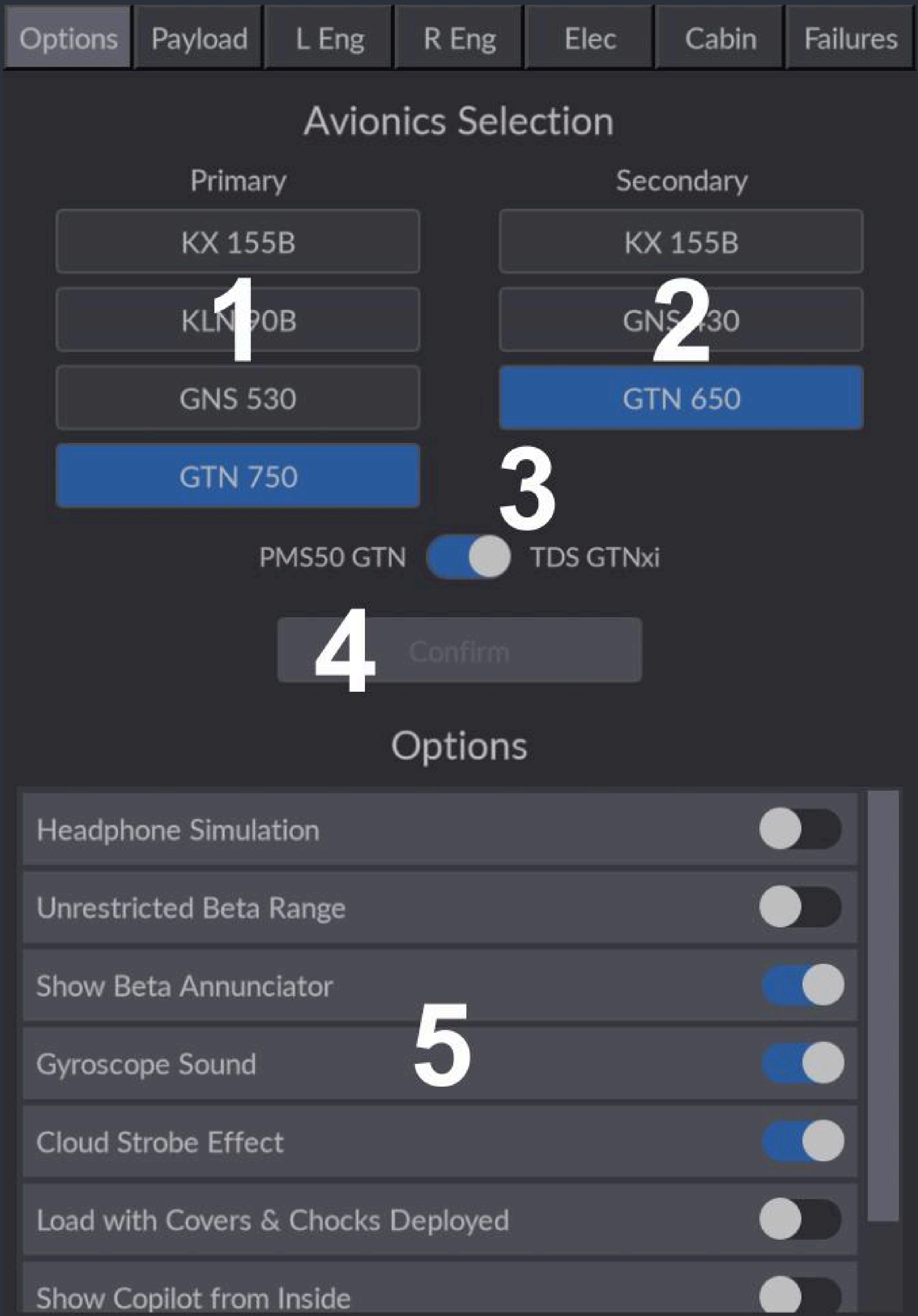
To switch between the PMS50 and TDS offerings of GTN GPS units, toggle this switch. This selection will be saved and recalled at the start of your next flight.

4. Confirm Avionics Selection

Your avionics selection will only take effect once you have pressed the confirm button. Once pressed, the button will display a series of messages while the avionics are reconfigured. This takes a few seconds, and should not be interrupted due to the complexity of new avionics software. The autopilot will be disengaged when this change takes effect. Once the change is complete, the confirm button will remain grayed out until you make a change to your avionics selection with the buttons above.

5. Options List

The scrolling options list contains all configuration options for the aircraft. Your selections will be saved and recalled at the start of your next flight.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Avionics Selection
Primary
Secondary
KX 155B
KX 155B
1
2
GNS 530
GTN 650
GTN 750
3
PMS50 GTN
TDS GTNxi
4
Confirm
Options
Headphone Simulation
Unrestricted Beta Range
Show Beta Annunciator
5
Gyroscope Sound
Cloud Strobe Effect
Load with Covers & Chocks Deployed
Show Copilot from Inside

Payload Page

NOTE: Using the payload configuration tools in this tablet interface is optional.

You may always use the simulator's native payload and fuel interface, though the two may be desynchronized when the aircraft is first loaded. This is a simulator limitation.

1. Payload Data

This text area contains real-time weight and balance information, as well as range and endurance estimates. The toggle switch above the payload data block can be used to switch units from gal/lbs to L/kg. The maximum gross weight will appear in red when it exceeds limits.

2. Exterior Actions

The buttons in this list execute actions pertaining to the exterior of the aircraft, such as opening doors, and refilling the oxygen cylinder. All cabin doors and baggage compartment doors can also be opened from the inside of the aircraft without the tablet interface. If a door fails to open, its operation is being impeded by the aircraft's condition, such as airflow around the aircraft, or the cabin pressurization. The oxygen cylinder can also be refilled via the weather radar display.

3. Fuel Stations

Each fuel tank in the aircraft is represented by a fuel block. Each block depicts the current fraction of the tank that is filled in the color of the fuel type appropriate to the aircraft, the total gallons or liters of fuel in the tank, and the weight of the fuel. Below each block is the name of the tank, and its maximum capacity. The quantity of the fuel in the tank can be adjusted with the up and down buttons, or the simulator's native payload interface.

4. Payload Stations

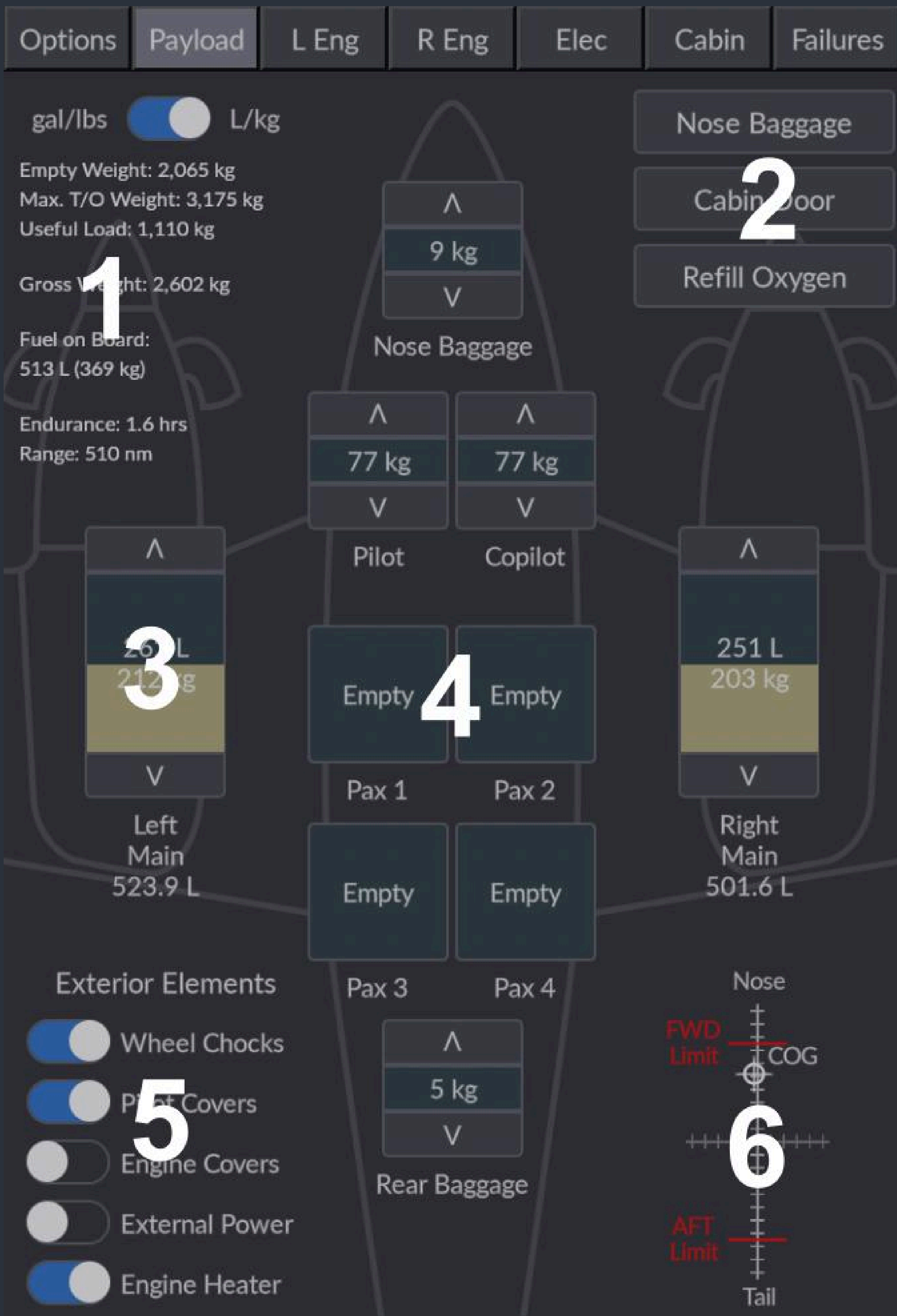
Each payload station in the aircraft is represented by a payload block. When occupied by passengers or cargo, each block shows the current weight of the station in its center. Clicking in the center of the block will toggle the payload between empty, and the default station weight. The weight of the payload station can be adjusted with the up and down buttons, or the simulator's native payload interface.

5. Exterior Elements

The toggle switches in this list control the visibility of exterior elements around the aircraft, such as wheel chocks and engine covers. The functioning wheel chocks can also be toggled by clicking on the stowed wheel chocks in the aircraft cabin.

6. Center of Gravity

This relative depiction of the center of gravity limitations can be used to assess the balance of your payload. When the aircraft's center of gravity exceeds the lateral or longitudinal limits, the crosshair will turn red.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
gal/lbs
L/kg
Empty Weight: 2,065 kg
Max. T/O Weight: 3,175 kg
Useful Load: 1,110 kg
Gross Weight: 2,602 kg
Fuel on Board:
513 L (369 kg)
Endurance: 1.6 hrs
Range: 510 nm
Nose Baggage
Cabin Door
Refill Oxygen
9 kg
Nose Baggage
77 kg
77 kg
Pilot
Copilot
251 L
203 kg
Empty
Empty
Pax 1
Pax 2
Left
Main
523.9 L
Right
Main
501.6 L
Empty
Empty
Pax 3
Pax 4
Exterior Elements
Wheel Chocks
Engine Covers
External Power
Engine Heater
5 kg
Rear Baggage
Nose
FWD
Limit
COG
AFT
Limit
Tail
1
2
3
4
5
6

Engine Visualizer Page

While the engine visualizer does not depict every operating parameter of the engine, as this would be a nearly impossible task, it depicts many of the parameters and conditions designed by Black Square that were previously invisible to users. This visualizer is probably most helpful for ensuring cool engine starts, but also for troubleshooting failures.

Cold Engine

This is how the engine visualizer will appear when the aircraft is first loaded on the ground.

1. Repair Engine

Clicking the Repair Engine button will reset only the engine's core condition, which can be observed on the adjacent engine condition bar. This action requires confirmation. Resetting the engine condition will not perform any of the actions performed by the column of buttons on this page, such as clearing the engine, or recharging the batteries. The engine condition can also be reset via the legacy weather radar systems display.

The engine condition is represented by a percentage of total engine health. When the engine's condition reaches 0%, a catastrophic failure will occur, and the engine will become inoperable. When the engine condition falls below 20%, the engine's performance will begin to suffer, making further degradation likely if power is not reduced immediately.

2. Engine Condition Reset Buttons

These buttons will not reset the engine's overall condition, but instead will reset individual elements of the engine's operating condition that may have become damaged or inoperable due to mismanagement, as opposed to failure.

The Clear Engine button will reset the engine temperatures to ambient, remove all fuel from the lines and combustion chamber, and prepare the engine for a normal cold start.

The Repair Starter button will reconnect the starter with the aircraft's electrical system, and set the starter's casing to the ambient temperature. The starter may become disconnected from the electrical system due to overuse, which results in a high temperature.

The Clean Filters button will remove any contaminants from the oil and fuel filters. These filters are depicted by cross-hatched rectangles in this visualizer. Clogged filters may result in higher than normal oil temperatures, or lower than normal fuel pressures, accompanied by a warning light.

The Recharge Battery button will fully recharge the battery, set its internal temperature to the ambient, and reconnect it with the hot battery bus. The battery may become disconnected from the hot battery bus if it is charged or discharged too quickly, which results in high temperatures.

The Refill Extinguisher will refill the fire extinguisher bottle.

3. Fuel & Oil Lines

This aircraft has two electric fuel pumps, one engine driven pump, an inline primary fuel filter which can become clogged, and an oil-to-fuel heat exchanger.

As oil is circulated through the engine's galleries, a brown slug of oil will move down the lines depicted on the engine visualizer. The speed at which oil permeates the engine is determined by the oil's viscosity. Oil viscosity is determined mostly by temperature. The color of the oil depicts its temperature. Dark browns indicate very cold and viscous oil. The oil has a large normal operating temperature span, throughout which its color will be the brown seen below.

4. Output Shaft

On the front of the engine is the output shaft, which is directly connected to the propeller. This shaft drives the propeller governor, and incorporates the torqometer, and beta feedback ring.

5. Planetary Reduction Gearbox

The planetary reduction gearbox is responsible for reducing the 30,000+ shaft RPM of the power turbine to a higher torque and more useful speed to drive the propeller. Since this is such a high wear area of the engine, it receives a constant flow of oil, and has its own oil sump.

6. Power Turbine

The power turbine blades are positioned just downstream of the combustion chamber, and capture the energy of the rapidly expanding exhaust gasses. One of the three turbines in this section returns power back to the gas generator to sustain combustion. Important to the understanding of free turbines, the power turbine and the gas generator are not connected by a common shaft or gears. There is no mechanical connection between the two sections. Instead, only the airflow that passes between the two connects them.

7. Gas Generator

The gas generator comprises a set of turbines and stators that progressively compress ram air to about ten times its ambient density. This air is then distributed through small holes into the combustion chamber. The gas generator is driven by expanding exhaust gasses when the engine is running, and the starter motor while starting.

8. Accessory Gearbox

The accessory gearbox resides on the back of the engine, and is used to transfer power from the gas generator to accessory equipment, such as fuel and oil pumps, the fuel control unit, and the starter-generator. The gearbox contains reduction gears to reduce the high RPM, low torque output of the gas generator to lower RPM, higher torque output for the accessories. It is important to remember that in a free turbine engine, accessories are driven by the gas generator, not the propeller output shaft. The main oil reservoir and sump separate the accessory gearbox from the rest of the engine.

9. Induction & Bleed Air Controls

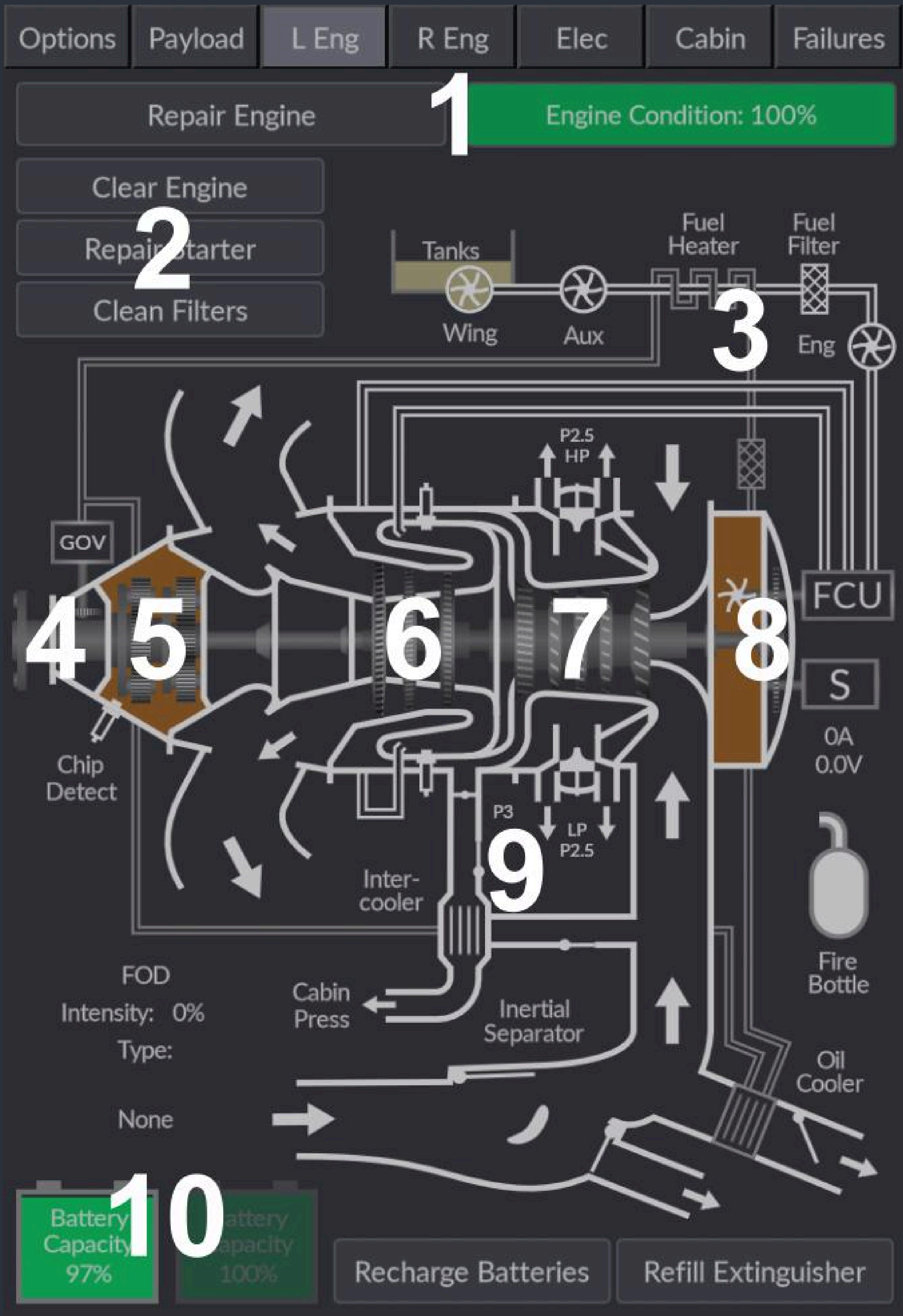
Control of the engine's intake and bleed air relies on a series of valves and louvers. Ambient air enters the induction system through the air inlet under each engine, at the bottom of the visualizer. This air is always at the same temperature and pressure as the air surrounding the aircraft.

While not technically part of the induction air system, the intercooler air is supplied by the same ambient air, only through ducts at the roots of the wings. This air is used to cool pressurization and heating air that is extracted from the P3 bleed air valve. The intercooler bypass valve can be used to limit the cooling air received by the intercoolers, thus raising the air plenum temperature. See the "Cabin Environmental Controls" section of this manual for more information on the intercooler bypass controls.

When ambient pressure and temperature ram air reaches the gas generator, it is pressurized before entering the combustion chamber. Unlike the reciprocating engine version of this aircraft, the air used for heating and pressurization is extracted just before the combustion chamber at the P3 bleed air valve. This air is metered by the bleed air controller, before being passed through the intercooler, and sent into the cabin air plenum. Should the bleed air become contaminated, such as by a carbon monoxide leak, a valve can be opened in the pressurization air duct to dump this pressure overboard, into the engine nacelle. See the "Cabin Environmental Controls" section of this manual for more information on the pressurization shutoff controls.

10. Active & Inactive Batteries

The capacity of each battery is displayed as a percentage of total amp-hours remaining. Batteries should generally not be discharged below 70-80% of their total capacity, unless they are specially designed "deep-cycle" batteries. When a battery is not connected to the main bus of the aircraft, it will appear grayed out.



Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Repair Engine
1
Engine Condition: 100%
Clear Engine
2
Repair Starter
Clean Filters
Tanks
Fuel Heater
Fuel Filter
Wing
Aux
3
Eng
P2.5 HP
GOV
FCU
4
5
6
7
8
S
0A
0.0V
Chip Detect
P3
LP P2.5
9
Inter-cooler
Fire Bottle
FOD
Intensity: 0%
Type:
None
Cabin Press
Inertial Separator
Oil Cooler
Battery Capacity 97%
10
Battery Capacity 100%
Recharge Batteries
Refill Extinguisher

Starting Engine

This visualizer can be very helpful for understanding the starting sequence of a free turbine engine, and learning how to keep the engine as cool as possible during starting.

1. Fuel Pumps

This aircraft has two electric fuel pumps and one engine driven pump, which serve different purposes. For more information on the different fuel pumps, see the “Fuel Pumps” section of this manual.

When an electric or engine-driven fuel pump runs, fuel will flow from the tanks into the fuel control unit (FCU). As the fuel lines are pressurized, a slug of fuel will travel from the tanks to the FCU. Dashed lines indicate the rate of fuel flow. Not until this slug reaches the FCU will the engine be capable of sustaining combustion.

2. Ignitors

In order to ignite the relatively non-volatile jet fuel, several ignitors are mounted radially around the combustion chamber. Not unlike spark plugs in a reciprocating engine aircraft, an exciter coil sends a high voltage pulse of electricity to these electrodes to produce a spark. The ignitors can be run automatically, whenever the engine is at low power output, or manually, usually when the aircraft encounters severe turbulence or precipitation. See the “Turbine Engine Ignition” section of this manual for more information

3. Fuel Control Unit & Starter Motor

The fuel control unit (FCU) is a purely mechanical control system in a turbine engine that meters the amount of fuel injected into the combustion chamber to achieve the desired power output level set by the power lever. A combination of pressurized fuel and pressurized bleed air are provided as inputs to the FCU. When the FCU is receiving pressurized fuel and functioning normally, its internal volume will be shown in green. When an FCU failure has occurred, it will be shown in red. For more information on the FCU and its possible failures, see the “Turbine Engine Fuel Control Failures” section of this manual.

When the starter motor is in use, the interior body of the starter will be depicted in green. Should the starter fail, it will turn red. Since the starter motor is also the generator, the interior body will also be green when the generator is in use, except the letter “G” will be shown, instead of “S” for starter.

The exterior casing of the starter-generator will change color to indicate its temperature. When the starter-generator is cold, the casing color will be gray. As it warms the color will change from blues and greens, to ambers and reds.

4. Intake Air

The gasses in the intake manifold are color-coded not for temperature, but pressure. Fully saturated, bright blue indicates sea level pressure. Darker blues indicate higher pressures, and greens and yellows indicate lower than sea level pressures. Seen here, the intake air is at the same pressure as the ambient air, but the air in the combustion chamber has been compressed by the gas generator. Before the engine is sustaining combustion the P2.5 bleed air valves will be open, as there is no P3 bleed air pressure to close them. For more information on P2.5 bleed valve operation and failures, see the “P2.5 Bleed Air Valves” section of this manual.

5. Battery Temperature

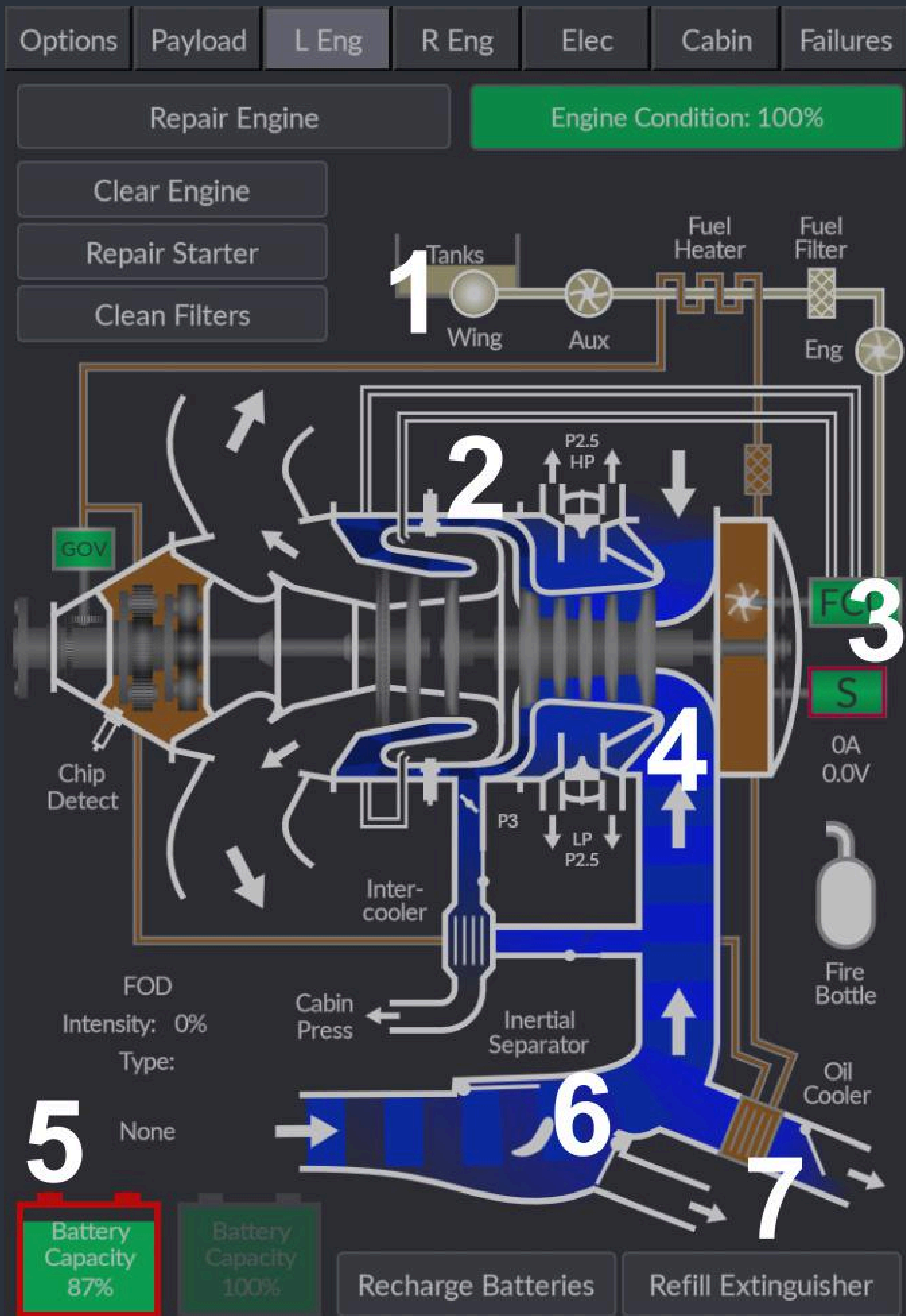
Here, the left battery can be seen connected to the main electrical bus, and the right is disconnected. The exterior casing of the battery will change color to indicate the temperature of the battery’s terminals and electrodes. When the battery is cold, the casing color will be gray. As the battery warms the color will change from blues and greens, to ambers and reds. The battery’s absolute temperature can be monitored on the BTI-600 Dual Battery Temperature Monitor. For more information on battery charging and temperature, see the “Battery Temperature” section of this manual.

6. Inertial Separator Stowed

With the inertial separator in the stowed (normal) position, ram air will flow unimpeded through the intake manifold and into the engine’s radial inlet. While this configuration is best for engine performance and cooling, it allows foreign object debris (FOD) to enter the engine. For best practices regarding the inertial separator, see the “Inertial Separators (Ice Deflectors)“ section of this manual.

7. Oil Cooler Door

The oil cooler doors provide a way to meter the amount of intake air that passes over the oil cooler heat exchanger. The doors are actually positioned behind the oil coolers, but their opening and closing controls the restriction of air exiting the air intake, much as cowl flaps control reciprocating engine cooling air, despite being at the bottom of the engine cowling. The management of oil cooling is particularly important to the operation of this aircraft. See the “Oil Cooler Doors” section of this manual for information on when the doors should be opened or closed.



Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Repair Engine
Engine Condition: 100%
Clear Engine
Repair Starter
Clean Filters
Tanks
Wing
Aux
Fuel Heater
Fuel Filter
Eng
1
2
P2.5 HP
GOV
3
S
0A
0.0V
4
Chip Detect
P3
LP P2.5
Inter-cooler
Fire Bottle
FOD
Intensity: 0%
Type:
None
Cabin Press
Inertial Separator
Oil Cooler
5
6
7
Battery Capacity 87%
Battery Capacity 100%
Recharge Batteries
Refill Extinguisher

Running Engine

While the engine is running, the engine visualizer is best used for detecting component failure, monitoring air intake valve positions, and bleed air valve activation.

1. Propeller Governor

The propeller governor controls the pitch of the propeller to indirectly control engine torque and output shaft RPM. The governor's flyweights are driven by a mechanical connection to the output shaft, and meter the high pressure oil supply to the propeller hub. When the propeller governor is receiving oil and functioning properly, it will be depicted with a green body. The body will become red if the governor fails. For information on the testing and failure modes of the governor, see the "Propeller Governors" section of this manual.

2. Exhaust Gasses

When the engine has achieved self-sustaining combustion, the resultant exhaust gasses are expelled through the power turbine, and out the exhaust stubs on either side of the engine. While the intake gasses are color-coded for pressure, the exhaust gasses are color-coded for temperature. The color spectrum is the same as for the other elements discussed above. As the gasses warm, their color will change from yellows and oranges, to reds and magentas. Magenta should be considered dangerously hot for any equipment depicted in this visualizer.

3. Combustion Chamber

When the ignitors successfully light off self-sustaining combustion, flame will emanate from the fuel injector nozzles. This engine has two injector circuits, primary and secondary. The primary injectors work alone when the engine is spooling up from a cold start, while the secondary injectors begin to function at around 40% Ng. Should an injector fail, fuel will not be shown in the pipeline, and the flame will be absent.

4. Bleed Air Valves

This engine has three bleed air valves. P3 bleed air is drawn from just prior to the combustion chamber, and is used to supply the heating and pressurization system. The low pressure and high pressure P2.5 bleed valves help maintain the correct engine operating RPM, and are sometimes used for heating and pressurization in other aircraft. The position of these valves is indicated on the visualizer. Should a valve fail and become stuck open, the valve body will be shown in red. For more information on P2.5 bleed valve operation and failures, see the "P2.5 Bleed Air Valves" section of this manual.

5. Oil Pumps, sumps & Lines

While dark brown oil in the lines indicated very cold and viscous oil, red indicates oil that is too hot. Here, the engine driven oil pump can also be seen running inside the main engine oil sump. The oil cooler door is also now shown in the open position.

6. Chip Detector

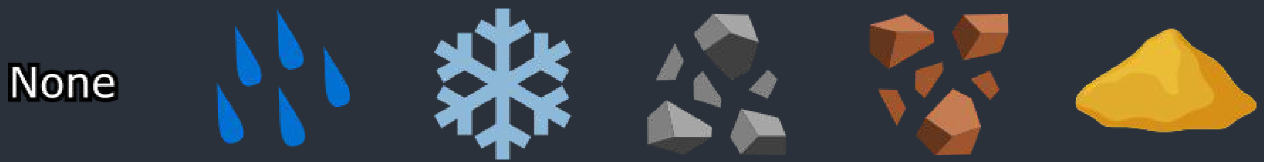
The chip detector is a magnetic pair of electrodes at the bottom of the planetary reduction gearbox oil sump. This is the most likely location in the engine for metallic particles to collect due to wear. The magnet attracts the particulate, and the electrodes allow for a complete circuit to be created when the metallic particles collect on them. When the presence of metal particles in the oil is detected, the body of the chip detector will show red, and a warning light will illuminate on the instrument panel. A chip detect warning is usually indicative of an incipient engine failure, and power should be reduced immediately.

7. Fire Extinguisher Bottle

The extinguisher bottle shows the level of retardant in the bottle. When the bottle is empty, the letter “E” will be visible. The presence of lines emanating from the nozzle indicates that the bottle is currently dispensing retardant inside the engine nacelle. The fire bottles can be refilled with the “Refill Extinguisher” button.

8. Foreign Object Debris (FOD)

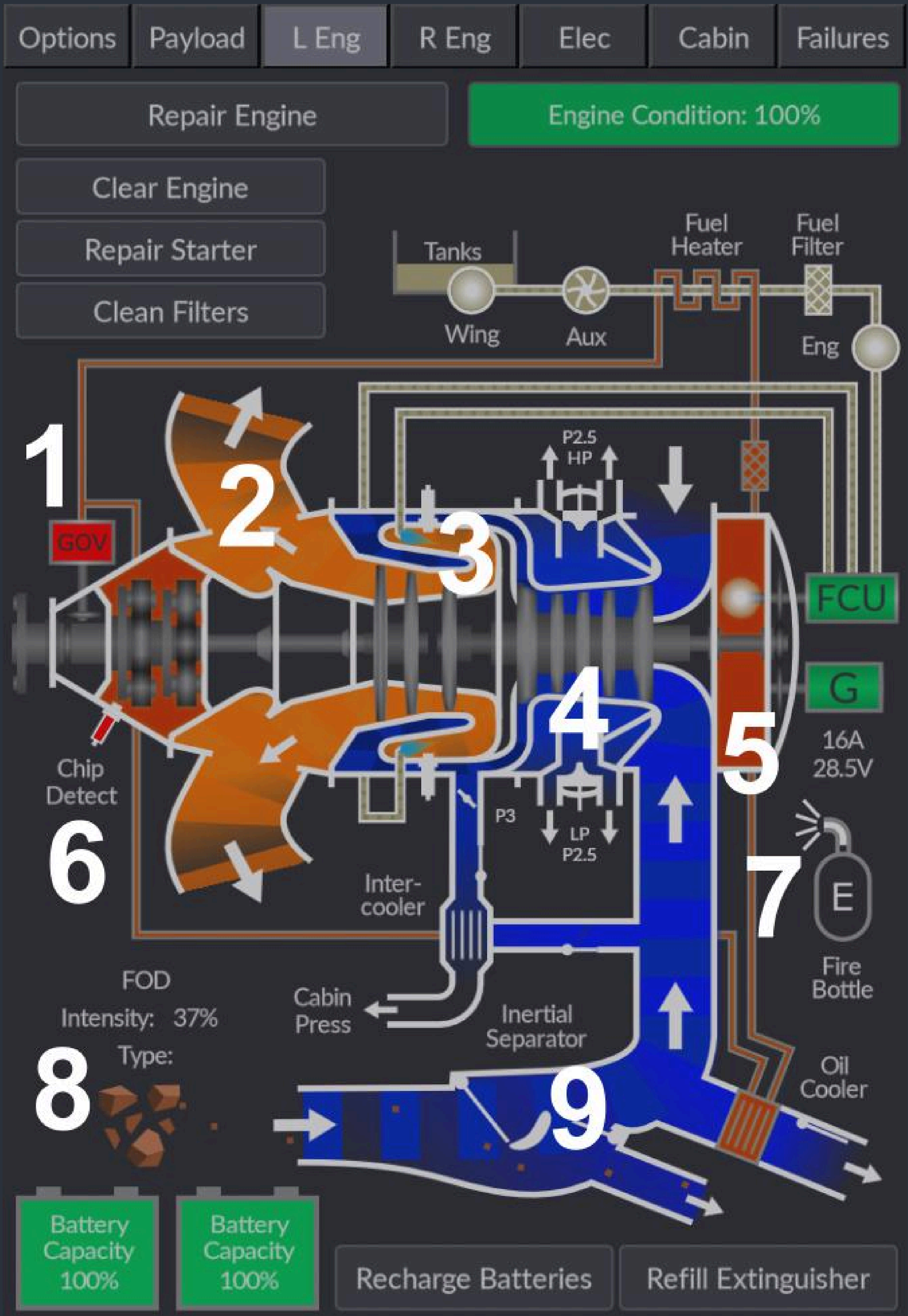
It is possible to encounter Foreign Object Debris (FOD) whenever operating on the ground, particularly on unimproved or worn surfaces. FOD can also enter the engine in flight in the form of ice, heavy precipitation, or birds. An icon representing the current type of FOD being encountered will appear on this visualizer. The intensity of the FOD is expressed as a number from 0 to 100%. Particles of FOD can be seen entering the air inlet, and flowing either into the engine or out the ejection ports, depending on how the inertial separator is positioned. For more information on the avoidance of FOD, and the consequences of encountering FOD, see the “Foreign Object Debris Damage” section of this manual.



No FOD	Rain	Ice/Snow	Asphalt/Stone	Dirt	Sand

9. Inertial Separator Deployed

When the inertial separator is in the fully deployed (bypass) position, any Foreign Object Debris (FOD) that enters the engine air intake below the propeller will flow harmlessly out the ejection ports at the rear of the nacelle. If the inertial separator’s louvers fail to fully deploy, the amount of FOD admitted to the engine is proportional to their position. For best practices regarding the inertial separator, see the “Inertial Separators (Ice Deflectors)“ section of this manual.



Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Repair Engine
Engine Condition: 100%
Clear Engine
Repair Starter
Clean Filters
Tanks
Wing
Aux
Fuel Heater
Fuel Filter
Eng
1
GOV
2
3
P2.5 HP
FCU
G
4
5
16A
28.5V
Chip Detect
6
P3
LP P2.5
7
E
Fire Bottle
Inter-cooler
FOD
Intensity: 37%
Type:
Cabin Press
Inertial Separator
8
9
Oil Cooler
Battery Capacity 100%
Battery Capacity 100%
Recharge Batteries
Refill Extinguisher

Live Schematic Page

The live schematic in the tablet interface is an almost identical recreation of the static schematic in the “Overview Electrical Schematic” section of this manual. For more information on the enhanced electrical simulation of this aircraft, also see the “Electrical Systems” section of this manual.

1. Voltmeter

Voltmeters measure the electrical potential between two points in the aircraft’s electrical system. Here, the direct current (DC) voltmeter measures the voltage between the main bus, and the chassis (ground) of the aircraft. A second alternating current (AC) voltmeter measures the voltage output by the windshield heat inverter.   As opposed to current measuring devices, voltmeters are depicted beside the point at which they measure voltage, or across two points between which the potential is measured, rather than as in-line devices.

2. Active & Inactive Equipment

When a circuit component, such as a starter motor, is inactive, it will be grayed out.

3. Buses & Circuit Connections

An electrical bus is any point in an electrical system at which multiple circuits, or other buses, attach. They are often solid pieces of conductive metal to which many wires attach, though they can also be purely conceptual, and used to aid your understanding of the system.

Connections between circuit elements and buses are depicted with solid lines and “hop-overs” wherever two lines must cross without making contact. In this live schematic, buses and circuit connections receiving any voltage from the battery, generators, or external power are highlighted in green, and are otherwise red. For the sake of readability, some circuit connections appear in red when no apparent switch isolates that part of the circuit from normally powered buses. For example, the circuit connection to the external power plug remains red, even when the main bus is powered.

Logic or signal connections, which do not carry any meaningful current, are depicted as dashed lines. For example, in this aircraft, the avionics controller sends a trigger voltage to the avionics contactors to close, thus supplying power to the avionics buses. A contactor is a large mechanical relay, often used in older aircraft for switching large loads.

4. Switches

Toggle switches control whether a circuit is open or closed. Wherever possible, the switches in the live schematic will be oriented so that the head of the toggle switch points towards the direction of current flow when it is in the on position.

5. Loadmeters

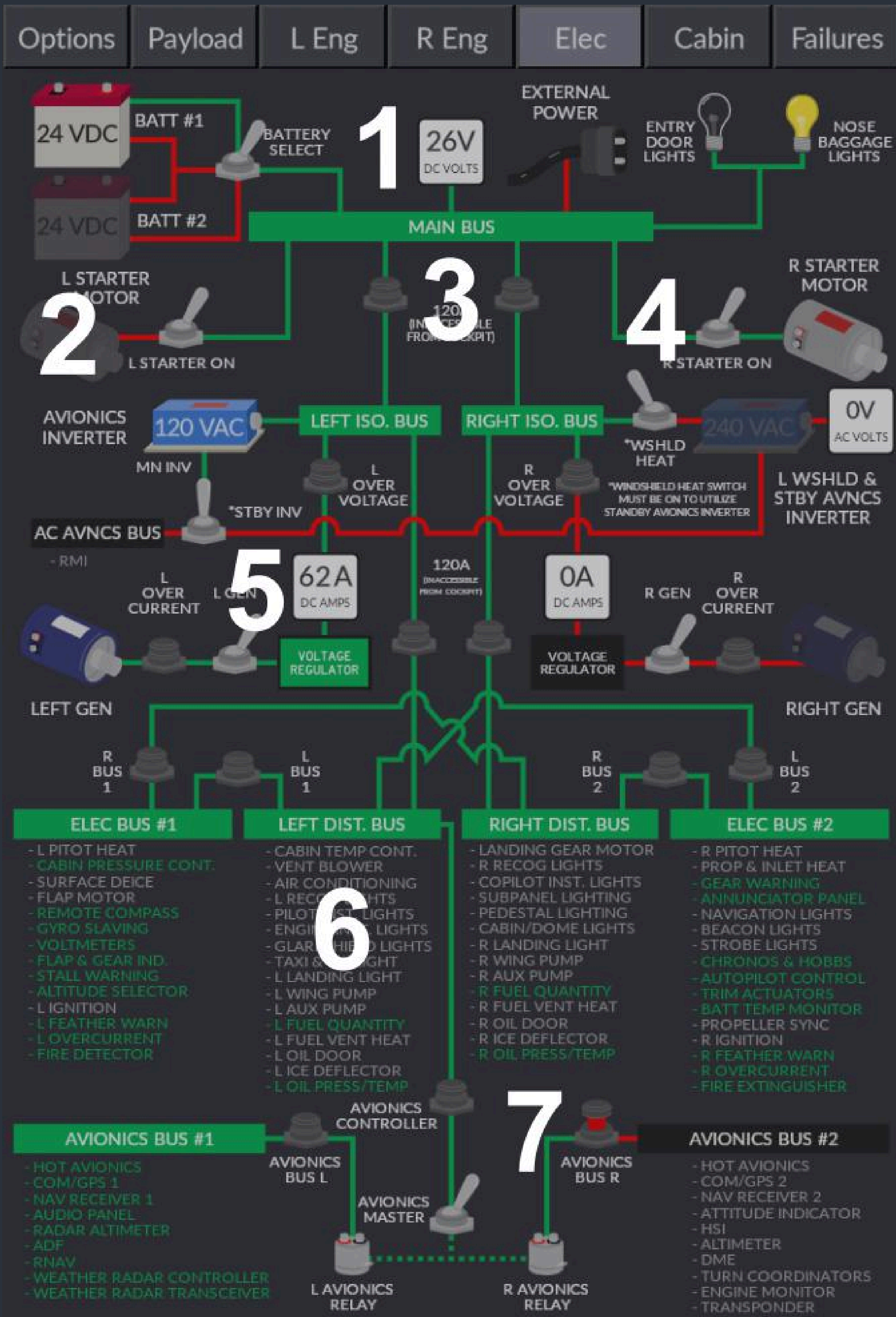
The load meters in most light aircraft do not indicate the total load required of the aircraft's electrical system for all of its electrical equipment. Instead, the loadmeters indicate the load on each generator. This will always be a positive number, as opposed to ammeters in aircraft that can be used to observe battery charge and discharge rates. As opposed to voltmeters, current measuring devices are depicted as in-line with their load, rather than as point measurements.

6. Circuits

Each circuit for an individual piece of equipment in the aircraft is represented on this schematic. When the circuit is in use and powered, its name will be highlighted in green. Otherwise, the name will be grayed out.

7. Circuit Breakers

Circuit breakers will show their red collar when the breaker has been tripped by excessive current. The breaker can be reset manually by clicking on the tripped breaker in the cockpit. If the breaker has tripped due to a failure, it will trip again soon, assuming the circuit is still under load and producing heat. For more information on the circuit breaker layout and power distribution logic, see the "Circuit Breakers" section of this manual.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
24 VDC
BATT #1
24 VDC
BATT #2
BATTERY SELECT
1
26V
DC VOLTS
EXTERNAL POWER
ENTRY DOOR LIGHTS
NOSE BAGGAGE LIGHTS
MAIN BUS
L STARTER MOTOR
2
L STARTER ON
3
4
R STARTER MOTOR
R STARTER ON
AVIONICS INVERTER
120 VAC
LEFT ISO. BUS
RIGHT ISO. BUS
240 VAC
0V
AC VOLTS
*WSHLD HEAT
MN INV
L OVER VOLTAGE
R OVER VOLTAGE
*WINDSHIELD HEAT SWITCH MUST BE ON TO UTILIZE STANDBY AVIONICS INVERTER
L WSHLD & STBY AVNCS INVERTER
*STBY INV
AC AVNCS BUS
- RMI
L OVER CURRENT
5
62A
DC AMPS
120A
0A
DC AMPS
R GEN
R OVER CURRENT
VOLTAGE REGULATOR
VOLTAGE REGULATOR
LEFT GEN
RIGHT GEN
R BUS 1
L BUS 1
R BUS 2
L BUS 2
ELEC BUS #1
LEFT DIST. BUS
RIGHT DIST. BUS
ELEC BUS #2
- L PITOT HEAT
- CABIN PRESSURE CONT.
- SURFACE DEICE
- FLAP MOTOR
- REMOTE COMPASS
- GYRO SLAVING
- VOLTMETERS
- FLAP & GEAR IND.
- STALL WARNING
- ALTITUDE SELECTOR
- L IGNITION
- L FEATHER WARN
- L OVERCURRENT
- FIRE DETECTOR
- CABIN TEMP CONT.
- VENT BLOWER
- AIR CONDITIONING
- L LANDING LIGHT
- L WING PUMP
- L AUX PUMP
- L FUEL QUANTITY
- L FUEL VENT HEAT
- L OIL DOOR
- L ICE DEFLECTOR
- L OIL PRESS/TEMP
6
- LANDING GEAR MOTOR
- R RECOG LIGHTS
- COPILOT INST. LIGHTS
- SUBPANEL LIGHTING
- PEDESTAL LIGHTING
- CABIN/DOME LIGHTS
- R LANDING LIGHT
- R WING PUMP
- R AUX PUMP
- R FUEL QUANTITY
- R FUEL VENT HEAT
- R OIL DOOR
- R ICE DEFLECTOR
- R OIL PRESS/TEMP
- R PITOT HEAT
- PROP & INLET HEAT
- GEAR WARNING
- ANNUNCIATOR PANEL
- NAVIGATION LIGHTS
- BEACON LIGHTS
- STROBE LIGHTS
- CHRONOS & HOBBS
- AUTOPILOT CONTROL
- TRIM ACTUATORS
- BATT TEMP MONITOR
- PROPELLER SYNC
- R IGNITION
- R FEATHER WARN
- R OVERCURRENT
- FIRE EXTINGUISHER
AVIONICS CONTROLLER
7
AVIONICS BUS #1
AVIONICS BUS L
AVIONICS BUS R
AVIONICS BUS #2
- HOT AVIONICS
- COM/GPS 1
- NAV RECEIVER 1
- AUDIO PANEL
- RADAR ALTIMETER
- ADF
- RNAV
- WEATHER RADAR CONTROLLER
- WEATHER RADAR TRANSCEIVER
AVIONICS MASTER
L AVIONICS RELAY
R AVIONICS RELAY
- HOT AVIONICS
- COM/GPS 2
- NAV RECEIVER 2
- ATTITUDE INDICATOR
- HSI
- ALTIMETER
- DME
- TURN COORDINATORS
- ENGINE MONITOR
- TRANSPONDER

Cabin Climate Visualizer Page

With such high performance aircraft, the environmental control systems begin to approach the complexity of light jets and commuter aircraft, and understanding them is paramount to safety.

Heating Cabin

When the desired cabin temperature is warmer than the outside ambient air, heating is provided by the pressurized P3 bleed air. The bleed air is heated by compression, and by being in proximity to the engine's combustion chamber. For more information on the environmental control systems, see the “Environmental Simulation & Controls” section of this manual.

1. Cabin Ram Air Intake

On the right side of the aircraft’s nose, a NACA duct sources ram air for the cabin, avionics cooling, and the combustion heater’s combustion chamber, the last of which is disabled in this aircraft for reasons discussed later. This air is divided in a distribution box surrounding the vent.

At the back of this box are two valves that separate the distribution box from the cabin. The outermost vent is controlled via the “CABIN AIR” pull handle in the cockpit. This valve can be opened when the aircraft is operating unpressurized and unheated, to allow ambient ram air to enter the cabin. This valve should also be opened in the event of a cabin air emergency, such as smoke in the cabin, or acrid burning smells, once the cabin has been depressurized.

To prevent opening of the cabin air valve from depressurizing the cabin, a check valve is installed between the cabin air valve and the cabin volume. This check valve will be held closed whenever the cabin pressure differential is non-negligible, separating the cabin from the ram air.

2. Combustion Heater

Unlike the reciprocating engine version of this aircraft, the combustion heater does not provide any heating to the aircraft, and will never be activated by the temperature controller. The heater has been disabled, because it is not certified for use with jet aircraft fuels, as opposed to aviation fuels. All heating in the aircraft is accomplished via the P3 engine bleed air.

3. Pressurization Shutoff & Carbon Monoxide

Carbon monoxide leaks are indicated in this visualizer by the presence of gray gradients emanating from either engine. In the event that carbon monoxide is detected, the suspect engine should be isolated from the cabin air. The red pressurization shutoff valves are used to isolate the engines, with the left appearing in the closed position here, and the right open. These shutoff valves can also be used to check the functioning of the pressurized air supply from each engine during runup checks. For more information on the pressurization shutoff valves and carbon monoxide, see the “Cabin Pressurization System”, and “Carbon Monoxide Detector” sections of this manual.

4. Intercooler Bypass

The intercooler bypass valves, here seen open on the left and closed on the right, serve to meter the amount of cooling air supplied to the pressurization and heating air intercoolers, located in the ducts under each wing root. The pull handles controlling these valves are labeled “PRESSURIZATION AIR TEMP PULL TO INCREASE” in the cockpit. Maintaining adequate cabin temperature at altitude, and not overheating the plenum on the ground, requires the careful management of these valves. See the “Cabin Environmental Controls” section of this manual for more information.

5. Cabin Air Plenum

The cabin air plenum is a volume of air created by the intake of ram air, and/or heated pressurization air from each engine’s compressor. This is the baseline temperature for all heating and cooling in the aircraft. The air in the plenum can be heated above the outside ambient by closing the intercooler bypass valves. On the ground, the plenum air will be heated by solar radiation, along with the rest of the cabin.

The cabin vent blower fan resides inside the plenum. It is used to blow air through the heating and cooling systems, and into the cabin. The vent blower can be used to equalize the cabin temperature without the outside air, or to increase the rate of heating or cooling.

6. Air Vents & Temperature Controller

The cabin outlet air vents in the cockpit further meter flow of heating and cooling air into the cabin. The defroster valves are normally closed, while the pilot and copilot valves are normally open. All of these valves are controlled via pull handles on the instrument subpanel, discussed further in the “Cabin Environmental Controls” section of this manual.

The temperature controller is a simple electronic system which controls the heating and cooling subsystems of the aircraft, and a mixing valve between the combustion heater outlet (although it is disabled in this aircraft for reasons discussed above), and the cabin vents. Here, the valve is in the full heating position, admitting as much heated air as possible to the cabin, as opposed to the possibly cooler air after the air conditioning evaporator.

7. Main Cabin Volume & Vents

The temperature of the main cabin, and all ducts and vents in the visualizer, can be estimated from the same absolute temperature scale used elsewhere in this tablet interface. Dark blues are the coldest, greens and yellows are moderate, and reds and magentas are the hottest. The cabin’s current temperature is shown in Fahrenheit and Celsius at the bottom of the visualizer.

8. Cabin Pressurization Graph

To the left of the main cabin volume is a graph depicting the aircraft altitude (airplane symbol), and the cabin pressurization altitude (human symbol) on the same scale. When the two are sufficiently apart, the cabin differential pressure will be shown between them, always in red.

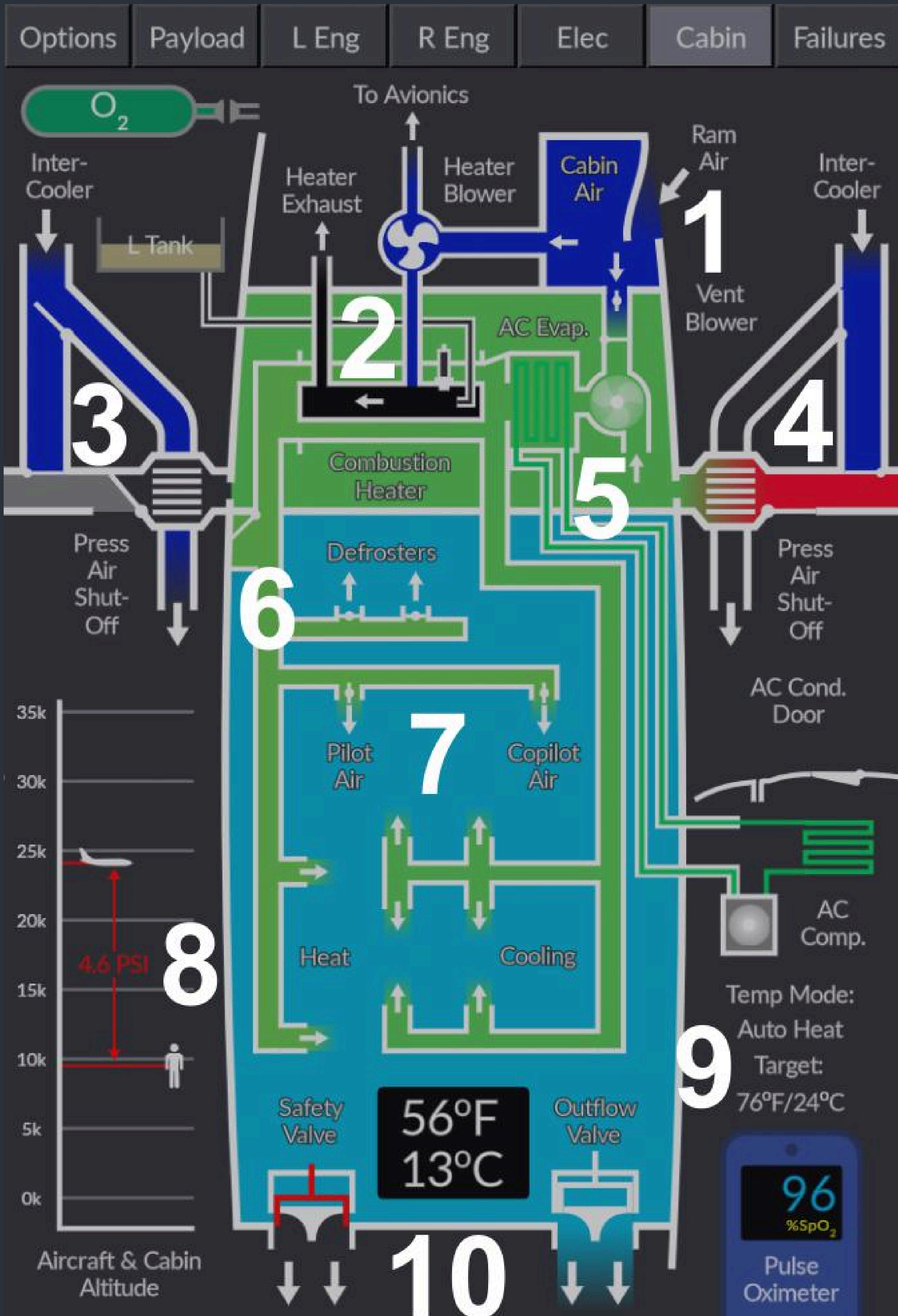
9. Climate Control Modes & Target

The operating mode of the climate control system is controlled by the “CABIN TEMP MODE” rotary selector switch discussed in the “Cabin Environmental Controls” section of this manual. This mode is annunciated, along with the temperature controller’s target cabin temperature, below the air conditioning compressor.

The target temperature will either be displayed as “MAX” or “MIN” in manual heating or cooling modes respectively, or the numeric set point of the “CABIN TEMP” rotary selector knob, when in automatic heating or cooling modes. Otherwise, the target will appear as “None”. When the target temperature is not attainable in the current ambient conditions, the target value will appear in red. This should be the operator’s cue to adjust the intercooler bypass valves while climbing, or that the air conditioner is operating at maximum capacity. Here, the automatic heating target temperature can be seen in degrees Fahrenheit and Celsius.

10. Safety & Outflow Valves

Cabin pressurization is controlled primarily by a set of two valves, the safety and outflow valves, on the aft pressure bulkhead of the aircraft. This complex topic is discussed at length in the “Cabin Pressurization System” section of this manual. Here, the outflow valve is open, venting the pressurized cabin air to atmosphere. The safety valve is closed, as it should be during normal operation. Its red coloration indicates that it has suffered a failure, and will not move from the closed position.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
O2
To Avionics
Inter-Cooler
Heater Exhaust
Heater Blower
Cabin Air
Ram Air
Inter-Cooler
1
L Tank
2
AC Evap.
Vent Blower
3
4
Combustion Heater
5
Press Air Shut-Off
Press Air Shut-Off
Defrosters
6
AC Cond. Door
35k
30k
25k
20k
15k
10k
5k
0k
Pilot Air
7
Copilot Air
4.6 PSI
8
Heat
Cooling
AC Comp.
Temp Mode: Auto Heat
Target: 76°F/24°C
9
Safety Valve
56°F 13°C
Outflow Valve
96
%SpO2
Pulse Oximeter
Aircraft & Cabin Altitude
10

Cooling Cabin

When the desired cabin temperature is below the outside ambient air temperature, cooling is provided by the vapor cycle cooling system, more commonly known as an air conditioner. For more information on the environmental control systems, see the "Environmental Simulation & Controls" section of this manual.

1. Oxygen Cylinder

The pressure of oxygen in the cylinder (a surrogate for the quantity remaining) is indicated by the green volume in the cylinder. This quantity can be refilled on the payload page of the tablet interface. The valve to the right of the cylinder, here seen in the open position, depicts the position of the oxygen valve, controlled via the knob on the pilot's side panel.

2. Cabin Ram Air Intake

As opposed to the cabin heating section above, which depicts an aircraft in flight, this screenshot depicts an aircraft on the ground with the air conditioning running. The outside ambient air temperature is warm, indicated by the yellow color of the ram air intake air. Also, the cabin air valve is in the open position, and the distribution box check valve is open, allowing ram air to flow into the cabin air plenum.

3. Intercooler Bypass & Pressurization Shutoff

Here, both the pressurization shutoff valves, and the intercooler bypass valves are in their normal operating positions.

4. Cabin Air Plenum & Air Conditioning Evaporator

Cooling of the cabin air plenum air is accomplished with an air conditioning evaporator, through which the cabin air flows, driven by the cabin vent blower. The insulated lines of the vapor cycle cooling system will change color to indicate that the system is operating.

5. Air Vents & Temperature Controller

The air vents and temperature controller operate as discussed in the cabin heating section, above. Here, the temperature controller mixing valve is positioned in the full cooling position, admitting as much cooling air to the cabin as possible.

6. Main Cabin Volume & Vents

The temperature of the main cabin, and all ducts and vents in the visualizer, can be estimated from the same absolute temperature scale used elsewhere in this tablet interface. Dark blues are the coldest, greens and yellows are moderate, and reds and magentas are the hottest. The cabin's current temperature is shown in Fahrenheit and Celsius at the bottom of the visualizer.

7. Air Conditioning Compressor, Condenser & Scoop

The air conditioning system (also known as the vapor cycle cooling system), is driven by a clutched compressor on the right engine. This compressor will only engage when the RPM of the engine is high enough, at which point the compressor will indicate with green on this visualizer, and the impeller will begin to rotate.

The uninsulated air conditioning pipes pass through a condenser in the right engine nacelle, which requires cooler ambient air to operate. A scoop on the top of the engine nacelle ensures the condenser receives the most airflow possible. The scoop will open to varying degrees throughout the flight. If the condenser scoop motor fails, or its limit switches fail, the door may become stuck. This will be indicated by a red condenser scoop door in this visualizer. For more information on the condenser scoop, see the “Air Conditioning Condenser Scoop” section of this manual.

8. Climate Control Modes & Target

The display of operating modes and target temperatures is discussed in the cabin heating section, above. Here, the manual cooling target temperature of “MIN” can be seen, which signifies that the temperature controller will cool the cabin to the minimum temperature possible.

9. Pulse Oximeter

Loss of conscientiousness and impaired cognitive functioning in low oxygen environments does not happen instantaneously. Except in the case of the most severe decompression events, oxygen must leave the blood supply in order for hypoxia to take effect. This process can take over an hour at lower cruising altitudes, or a few seconds at high altitude. Use the pulse oximeter to monitor the concentration of oxygen in the pilot’s bloodstream. If the concentration becomes too low, decrease the cabin pressurization altitude, descend if the cabin is unpressurized, or open the oxygen valve to use supplemental oxygen.

Generally speaking, 98% oxygen saturation (SpO_2) is normal at sea level for a healthy adult.

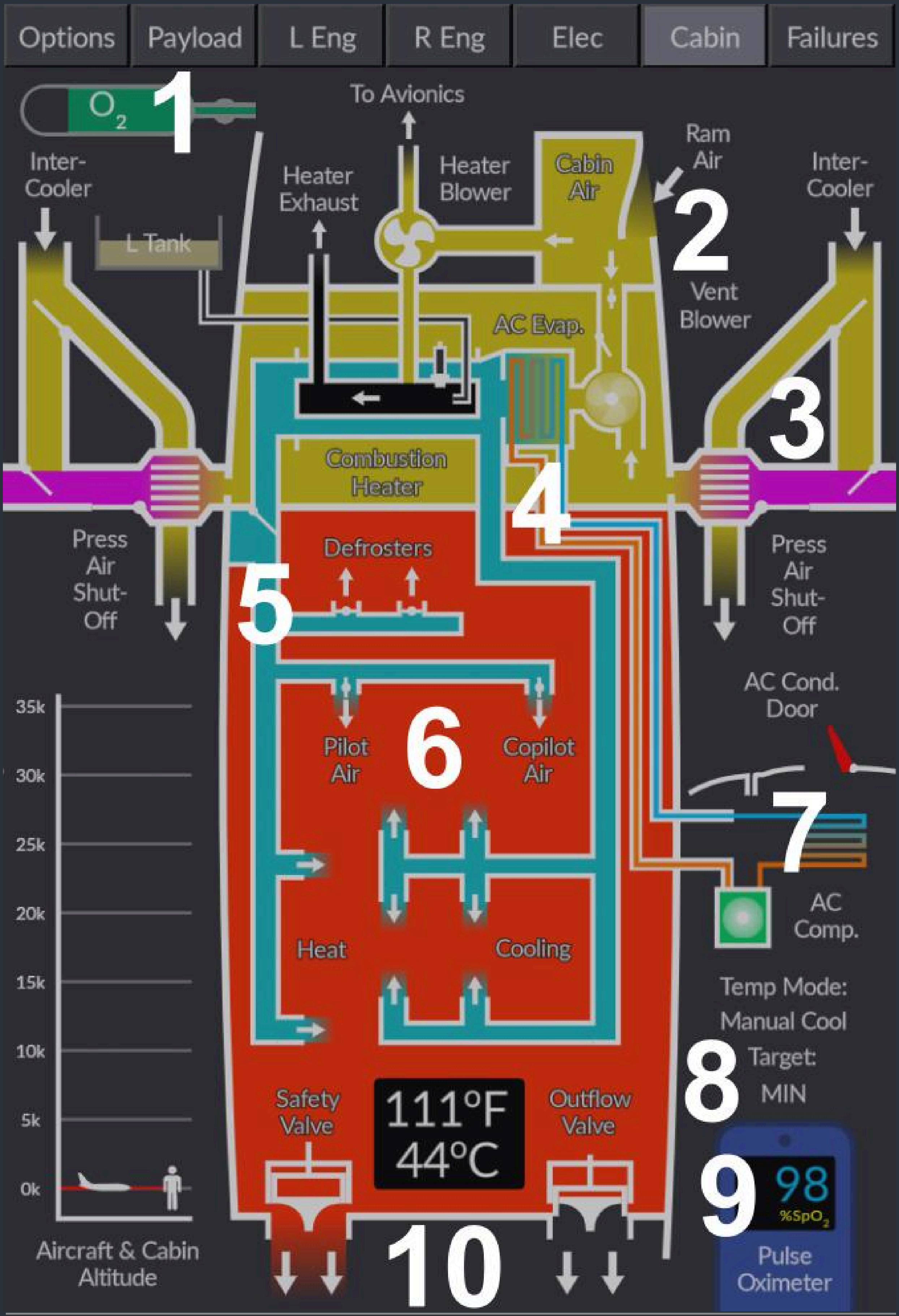
The recommended, and legally required, altitudes for supplemental oxygen use of around 12,000 - 14,000 feet correspond to an SpO_2 of roughly 90-92% for exposure under 60 minutes.

An SpO_2 below 90% results in cognitive impairment, possibly detrimental to flight safety.

An SpO_2 below 80% can lead to incapacitation after exposure of just a few minutes.

10. Safety & Outflow Valves

Cabin pressurization is controlled primarily by a set of two valves, the safety and outflow valves, on the aft pressure bulkhead of the aircraft. This complex topic is discussed at length in the “Cabin Pressurization System” section of this manual. Here, the outflow valve is closed, and the safety valve is open, because the landing gear weight on wheels sensor is activated. As neither valve is depicted in red, both are functioning properly.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
O2
1
To Avionics
Ram Air
Inter-Cooler
Heater Exhaust
Heater Blower
Cabin Air
Inter-Cooler
L Tank
2
Vent Blower
AC Evap.
3
Combustion Heater
4
Press Air Shut-Off
Defrosters
Press Air Shut-Off
5
AC Cond. Door
35k
30k
25k
20k
15k
10k
5k
0k
Pilot Air
6
Copilot Air
7
AC Comp.
Heat
Cooling
Temp Mode:
Manual Cool
Target:
MIN
8
Safety Valve
111°F
44°C
Outflow Valve
9
98
%SpO2
Aircraft & Cabin Altitude
10
Pulse Oximeter

Failures Page

This aircraft is equipped with an underlying software system that is capable of triggering a failure of almost any simulated aircraft system, in response to the users mismanagement of the aircraft, at appropriately timed random (MTBF) intervals, or within a scheduled window of time. These failures are managed through the failures page of the tablet interface. A list of all possible failures is provided below in the "List of Possible Failures" section of this manual. Failures are saved between flights, leaving you to discover what failed on the previous flight during your before flight checklists.

MTBF Failures

In Mean Time Between Failure (MTBF) mode, the user can set custom failure probabilities in the form of a mean time between failure time in hours. While real world electromechanical components follow an exponentially decaying failure probability after their fabrication, this would be inconvenient for users of virtual aircraft, since it would subject new users to high component mortality rates just after purchasing the product; therefore, the probability of component failure is constant throughout aircraft operation. This means that the probability of failure can be considered to be exactly the mean at all times.

While many of these failures may be randomly generated, they will feel like an authentic system failure (which are essentially random in real life), because they will only fail while the system is in use, and at a rate appropriate to the real world system.

1. Restore Defaults & Reset All Failures

The Restore Defaults button can be used to reset all MTBF times to their default value. As adjustments to MTBF times are saved and restored for the next flight, this action requires a confirmation to complete. For instructions on adjusting the MTBF time for individual components see point 6, below. The reset all failures button can be used to reset all currently active failures at once. For instructions on triggering individual failures, see point 7, below.

2. MTBF / Scheduled Mode Switch & Show Only Active Failures

Use the MTBF / Scheduled Mode switch to toggle between the two modes of operation for the failure system. The Show Only Active Failures switch can be used to filter the results of the scrolling failure list to only those that are currently active. This also applies to the results of the search function.

3. Global Failure Rate Slider

The global failure slider is used to control the global failure rate, indicated by the text below the slider. The maximum allowable rate is 1000 times real-time. All MTBF and scheduled failures can be disabled completely by positioning the slider all the way to the left, until "Failures Off" appears below the slider. The global failure rate multiplies the probability of random failures occurring while in MTBF mode, but does nothing in scheduled failure mode.

For Example, if a specific failure is expected to occur once in every 5,000 hrs of flight time, a global failure rate of 1000x, will result in this failure occurring roughly once in every 5 hrs of flight time instead. Settings between 10x and 50x are recommended to add a little excitement to your virtual flying experience, as many hundreds of hours can be flown at 1x real-time failures without encountering a single failure, while settings above 250x almost guarantee multiple failures per flight.

4. Active Failures

The current number of active failures can be seen at all times below the global failure rate slider. This number is also shown on the systems page of the weather radar display so that the number of current failures can be monitored from the cockpit without the tablet visible.

5. Search Failures

All failures shown in the scrolling list are searchable. Click in the search window and start typing to search. The text entry mode should deactivate automatically a few seconds after you stop typing. When the “show only active failures” option is selected, the search will only return results among the currently active failures.

6. Adjust MTBF

Upon loading the aircraft for the first time, default MTBF values will be displayed for each system, which are representative of their real world counterparts in accordance with published NASA guidelines whenever available. These failure probabilities can be modified by pressing the left and right arrow buttons beside the MTBF value. The minimum allowable MTBF is 100 hrs, and the maximum is 1,000,000 hrs. If adjusted from the default, the selected MTBF time will be saved and restored on the next flight.

7. Instantaneously Fail or Reset Failure

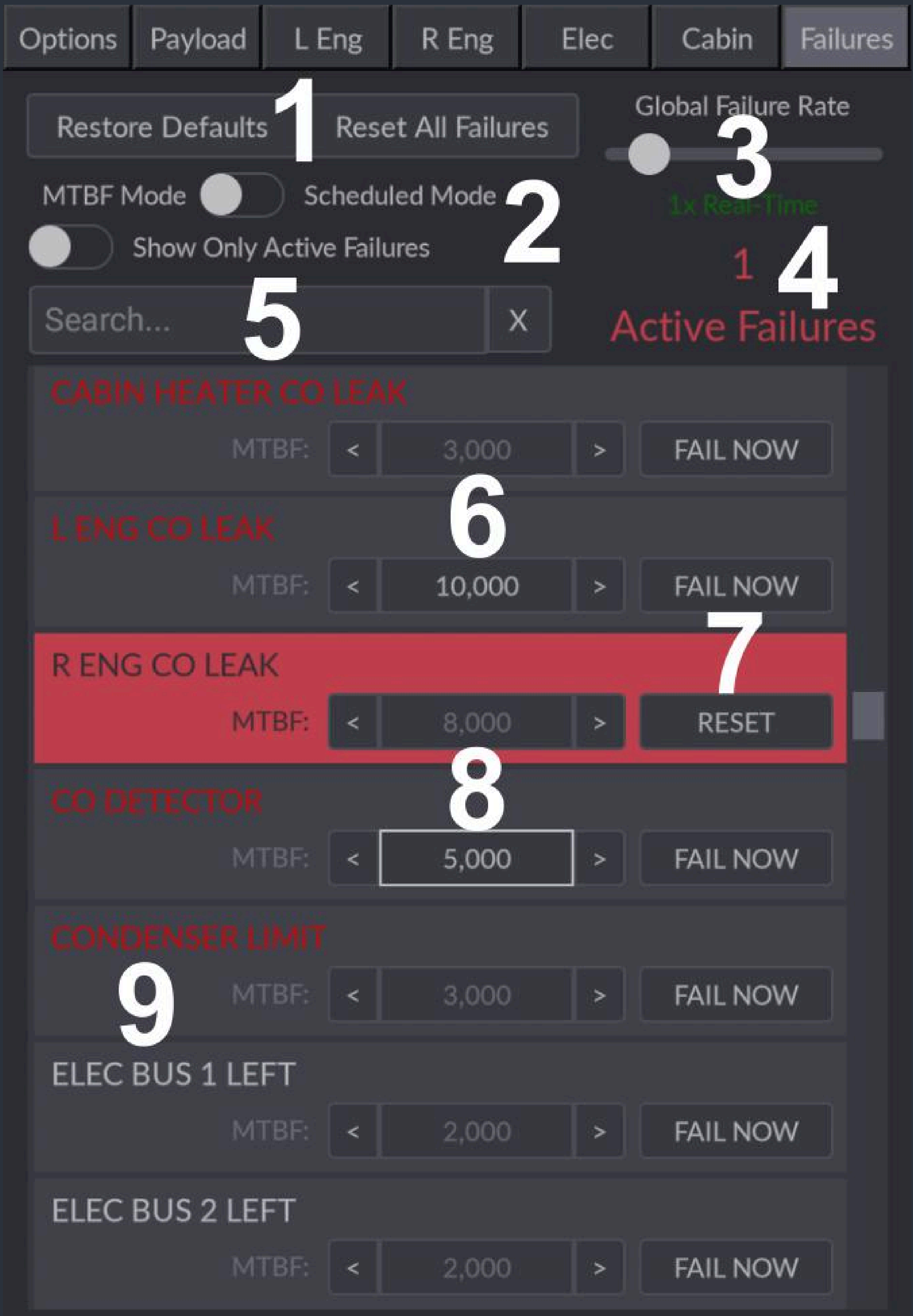
After being triggered by any means, individual failures can be reset by pressing the “RESET” button. Failures can also be triggered manually in this mode by pressing the “FAIL NOW” button.

8. Restore Default MTBF

Clicking on the displayed MTBF value will restore it to the default for that specific component. When the button is grayed out, the component’s MTBF is already set to the default value.

9. Failure Names & Color Codes

Failures are color coded into groups. Magenta is used for catastrophic engine failures, red for major systems failures, white for power distribution failures, and cyan for circuit breaker protected electromechanical failures. The failure names as they appear in this list can be used to trigger the failures via any 3rd party software or hardware interface that is capable of sending HTML (H:Events) to the simulator. See the “Failure System HTML Interface” section of this manual for more information.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Restore Defaults
1
Reset All Failures
Global Failure Rate
3
1x Real-Time
MTBF Mode
Scheduled Mode
2
Show Only Active Failures
1
4
Active Failures
Search...
5
X
CABIN HEATER CO LEAK
MTBF:
3,000
FAIL NOW
6
L ENG CO LEAK
MTBF:
10,000
FAIL NOW
7
R ENG CO LEAK
MTBF:
8,000
RESET
8
CO DETECTOR
MTBF:
5,000
FAIL NOW
CONDENSER LIMIT
9
MTBF:
3,000
FAIL NOW
ELEC BUS 1 LEFT
MTBF:
2,000
FAIL NOW
ELEC BUS 2 LEFT
MTBF:
2,000
FAIL NOW

Scheduled Failures

In scheduled failures mode, individual failures can be scheduled to occur within a specific time window after the present time. Failures have a constant probability of occurring between the two times shown, and will occur only after the failure has been armed. This allows for variability in scenario training, while ensuring that a given failure occurs in the desired phase of flight.

1. Restore Defaults & Reset All Failures

The Restore Defaults button can be used to reset all scheduled failure windows to the default. This action requires a confirmation to complete. For instructions on adjusting the scheduled failure time window for individual components see point 6, below. The Reset All Failures button can be used to reset all currently active failures at once.

2. MTBF / Scheduled Mode Switch & Show Only Active Failures

Use the MTBF / Scheduled Mode switch to toggle between the two modes of operation for the failure system. The Show Only Active Failures switch can be used to filter the results of the scrolling failure list to only those that are currently active. This also applies to the results of the search function.

3. Global Failure Rate Slider

The global failure rate has no effect on the rate of failures in the scheduled failure mode; however, it will prevent all failures from occurring when placed in the “No Failures” position.

4. Active Failures

The current number of active failures can be seen at all times below the global failure rate slider. This number is also shown on the systems page of the weather radar display so that the number of current failures can be monitored from the cockpit without the tablet visible.

5. Search Failures

All failures shown in the scrolling list are searchable. Click in the search window and start typing to search. The text entry mode should deactivate automatically a few seconds after you stop typing. When the “show only active failures” option is selected, the search will only return results among the currently active failures.

6. Adjust Time Window

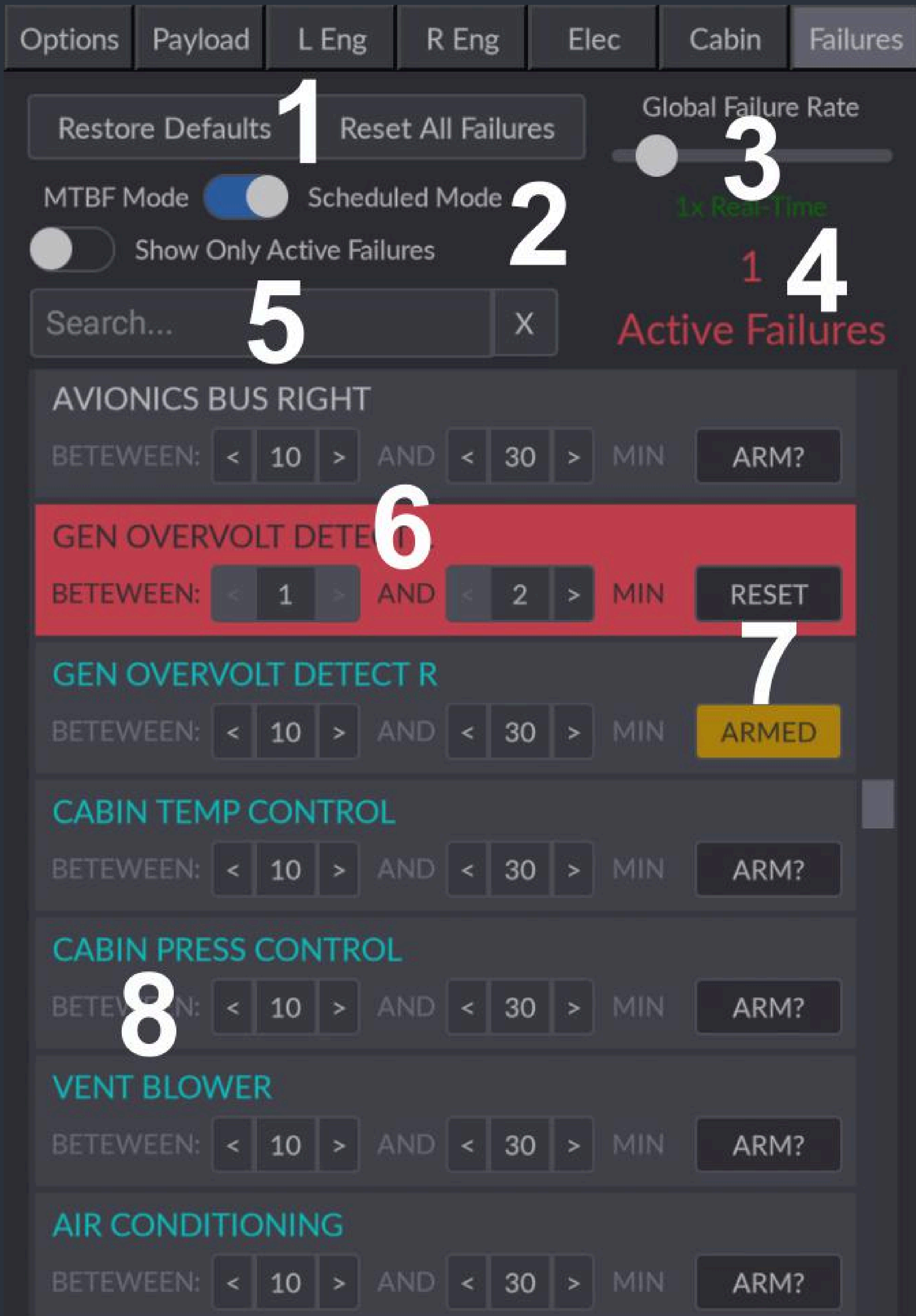
The time window in which a specific failure will occur can be adjusted with the arrow buttons beside the “after” and “before” times. These times are expressed in minutes. The minimum time after which a failure will occur is one minute, and the maximum time before which a failure will occur is ninety minutes. When the time cannot be adjusted up or down as it would exceed the minimum or maximum, or when it is constrained by the other time, the adjustment buttons will be grayed out.

7. Arm or Reset Failure

Clicking the “ARM?” button will arm the failure with the currently selected time window. Once armed, this button will appear in yellow, with the text “ARMED”. Clicking the button again anytime before the failure has occurred will disarm the failure. After the failure has occurred, the button will read “RESET”, and clicking the button will reset the failure, returning it to an unarmed state.

8. Failure Names & Color Codes

Failures are color coded into groups. Magenta is used for catastrophic engine failures, red for major systems failures, white for power distribution failures, and cyan for circuit breaker protected electromechanical failures. The failure names as they appear in this list can be used to trigger the failures via any 3rd party software or hardware interface that is capable of sending HTML (H:Events) to the simulator. See the “Failure System HTML Interface” section of this manual for more information.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Restore Defaults
1
Reset All Failures
Global Failure Rate
3
1x Real-Time
MTBF Mode
Scheduled Mode
2
Show Only Active Failures
1
4
Active Failures
Search...
5
X
AVIONICS BUS RIGHT
BETEWEEN: < 10 > AND < 30 > MIN
ARM?
GEN OVERVOLT DETECT L
6
BETEWEEN: < 1 > AND < 2 > MIN
RESET
7
GEN OVERVOLT DETECT R
BETEWEEN: < 10 > AND < 30 > MIN
ARMED
CABIN TEMP CONTROL
BETEWEEN: < 10 > AND < 30 > MIN
ARM?
CABIN PRESS CONTROL
8
BETEWEEN: < 10 > AND < 30 > MIN
ARM?
VENT BLOWER
BETEWEEN: < 10 > AND < 30 > MIN
ARM?
AIR CONDITIONING
BETEWEEN: < 10 > AND < 30 > MIN
ARM?

Failure System HTML Interface

To facilitate users who wish to initiate failures instantaneously via an external software interface, such as an instructor station, webpage, or tablet interface, access has been provided into the failure system using MSFS's HTML events. Any software that is capable of sending HTML events (also known as H:Vars), is capable of triggering failures without any additional configuration. These failures will appear in the in-cockpit tablet interface's failures page, and can be reset from the same interface, or by sending the same HTML event again.

This interface allows users to create and share profiles for popular 3rd party interface applications to trigger and reset failures, or even mimic more complex emergency scenarios. Popular software capable of sending HTML events to MSFS include:

- Air Manager
- Axis and Ohs
- Mobiflight
- SPAD.neXt
- FSUIPC
- Many other SimConnect-based interfaces

To trigger or reset any failure in any Black Square aircraft, simply send an HTML event with the prefix "BKSQ_FAILURE_", and the exact name of the failure as it appears in the in-cockpit tablet interface's failures page with spaces replaced by underscores.

For example, to trigger or reset a failure named "L FUEL QTY", the HTML event would be:

>H:BKSQ_FAILURE_L_FUEL_QTY

All failures can be reset at once by issuing the following command:

>H:BKSQ_FAILURE_RESET_ALL_FAILURES

Depending on your programming environment, be sure to check the exact syntax needed to trigger HTML events. Some graphical programming environments may require you to omit the leading ">" from the event, while others may require this ">" to be expressed as ">", such as in reverse polish notation.

List of Possible Failures

Major System Failures

L ENGINE FAILURE
L ENGINE FIRE
L GENERATOR
L PROP GOV
L ENGINE SURGE
L FUEL CONTROL
L PRIMARY INJECTORS
L SECONDARY INJECTORS
L FUEL FILTER
L LP BLEED
L HP BLEED

R ENGINE FAILURE
R ENGINE FIRE
R GENERATOR
R PROP GOV
R ENGINE SURGE
R FUEL CONTROL
R PRIMARY INJECTORS
R SECONDARY INJECTORS
R FUEL FILTER
R LP BLEED
R HP BLEED

INSTRUMENT AIR
INSTRUMENT AIR PARTIAL
PITOT BLOCKAGE
STATIC BLOCKAGE
L BRAKE
R BRAKE
L FUEL LEAK
R FUEL LEAK
CABIN SAFETY VALVE
CABIN OUTFLOW VALVE
INFLOW CONTROL UNIT
CABIN DOOR LATCH
NOSE DOOR LATCH
DEICE BOOTS INTEG
MAIN INVERTER
STANDBY INVERTER
BLEED AIR
OXYGEN LEAK
CO DETECTOR
CONDENSER LIMIT
GEAR CRANK HANDLE

Breaker Protected Failures

CABIN TEMP CONTROL
CABIN PRESS CONTROL
VENT BLOWER
AIR CONDITIONING
PITOT HEAT L
PITOT HEAT R
SURFACE DEICE
PROP DEICE
WINDSHIELD HEAT
FLAP MOTOR
GEAR MOTOR
GEAR WARNING
ANNUNCIATOR PANEL
NAV LIGHTS
BEACON AND STROBE
L LDG AND RECOG LTS
PLT AND ENG INST LTS
GLARESHIELD LTS
TAXI AND ICE LTS
AVNCS POWER CONTROL
R LDG AND RECOG LTS
COPLT AND AVNCS LTS
SUBPANEL AND PED LTS
DOME AND READING LTS
CHRONO AND HOBBS
REMOTE COMPASS
VOLT METERS
FLAPS AND GEAR IND
STALL WARNING
ENGINE INSTRUMENTS
ALTITUDE SELECTOR
AUTOPILOT CONTROLLER
AUTOPILOT ACTUATORS
BATTERY MONITOR
PROP SYNC
STARTER MOTORS
FUEL FLOW
L WING PUMP
R WING PUMP
L AUX PUMP
R AUX PUMP
L FUEL QTY
R FUEL QTY
L FUEL VENT HEAT
R FUEL VENT HEAT
L ICE DEFLECT
R ICE DEFLECT
L OIL DOOR
R OIL DOOR
L IGNITION
R IGNITION
L GEN OVERCURRENT
R GEN OVERCURRENT
L FEATHER WARN
R FEATHER WARN
L OIL TEMP PRESS
R OIL TEMP PRESS
FIRE DETECTORS
EXTINGUISHERS

COM 1
COM 2
NAV 1
NAV 2
AUDIO PANEL
RADAR ALTIMETER

PILOT ATTITUDE
PILOT HSI
PILOT ALTIMETER
ADF
RNAV
WX RADAR CONTROLLER
WX RADAR TRANSCEIVER
DME
TURN COORDINATORS
ENGINE MONITOR
TRANSPONDER

Power Distribution Failures

L OVERVOLTAGE
R OVERVOLTAGE
ELEC BUS 1 LEFT
ELEC BUS 2 LEFT
ELEC BUS 1 RIGHT
ELEC BUS 2 RIGHT
AVIONICS BUS LEFT
AVIONICS BUS RIGHT
GEN OVERVOLT DETECT L
GEN OVERVOLT DETECT

Miscellaneous Systems

Audible Warning Tones

The Turbine Duke comes equipped with several warning tones to alert the operator to important configuration changes, or potentially dangerous situations. These tones can be disabled by pulling the circuit breaker for the respective tone's underlying warning system. These tones are as follows:

- Altitude Alerter Tone: A traditional C-Chime will sound when the aircraft is within 1,000 ft of the selected altitude displayed on the PRE-80C Altitude Selector.
- Autopilot Disconnect Tone: Whenever the autopilot is disconnected via the autopilot master push button, the control yoke mounted disconnect buttons, or automatically disconnects when overpowered, a warning buzzer will sound.
- Stall Warning Horn: When the aircraft is within approximately 5-10 knots of stalling speed, a constant tone warning horn will sound.
- Overspeed Horn: When the aircraft exceeds the VNE (red line) airspeed on the airspeed indicator, a repeating beeping tone warning will sound until the speed of the aircraft is reduced to below VNE.
- Gear Configuration Warning Horn: When both power levers are reduced below approximately 20% of their travel, or the flaps are placed in their landing configuration, and the landing gear has not been deployed, a repeating tone will sound.
- Carbon Monoxide Detector: When a turbine engine becomes compromised, it is possible for poisonous gas to leak into the cabin of the aircraft. When this colorless, odorless, gas is present, a beeping alarm will sound. The alarm will continue to sound as long as the gas is present. Follow the checklists for Carbon Monoxide leaks, and close (pull) the cabin pressurization air shutoff valves immediately.

NOTE: Have you ever noticed that the wind sound in all other MSFS aircraft is erroneously based on true airspeed rather than indicated airspeed? This makes wind noise during high altitude cruise far too loud. All Black Square aircraft now have wind sounds based on indicated airspeed, which makes them much more enjoyable to fly at high true airspeed.

VOR & ADF Signal Degradation

Unlike in the real world, navigation receivers in Microsoft Flight Simulator produce only ideal readings. Signal strength is not affected by distance, altitude, terrain, or atmospheric conditions. When a station is out of range, the signal is abruptly switched off. This is unrealistic, and does not give the feel of navigating with the physical systems of the real aircraft.

All Steam Gauge Overhaul and Standalone Black Square aircraft solve this problem by providing variables for VOR and ADF indications with distance and height above terrain based signal attenuation and noise. This noise is mathematically accurate for the type of signal (phased VHF for VOR, and MF for NDB), and adheres to the international standards for station service volumes. Combined with the two-pole filtering and physics of the instrument's needles in the cockpit, this creates a very convincing facsimile of the real world instrument's behavior. The To-From indicators of the VOR instruments will even exhibit the fluttering that is characteristic of the "cone of confusion" directly over the ground-based stations that pilots are taught to recognize during instrument training.

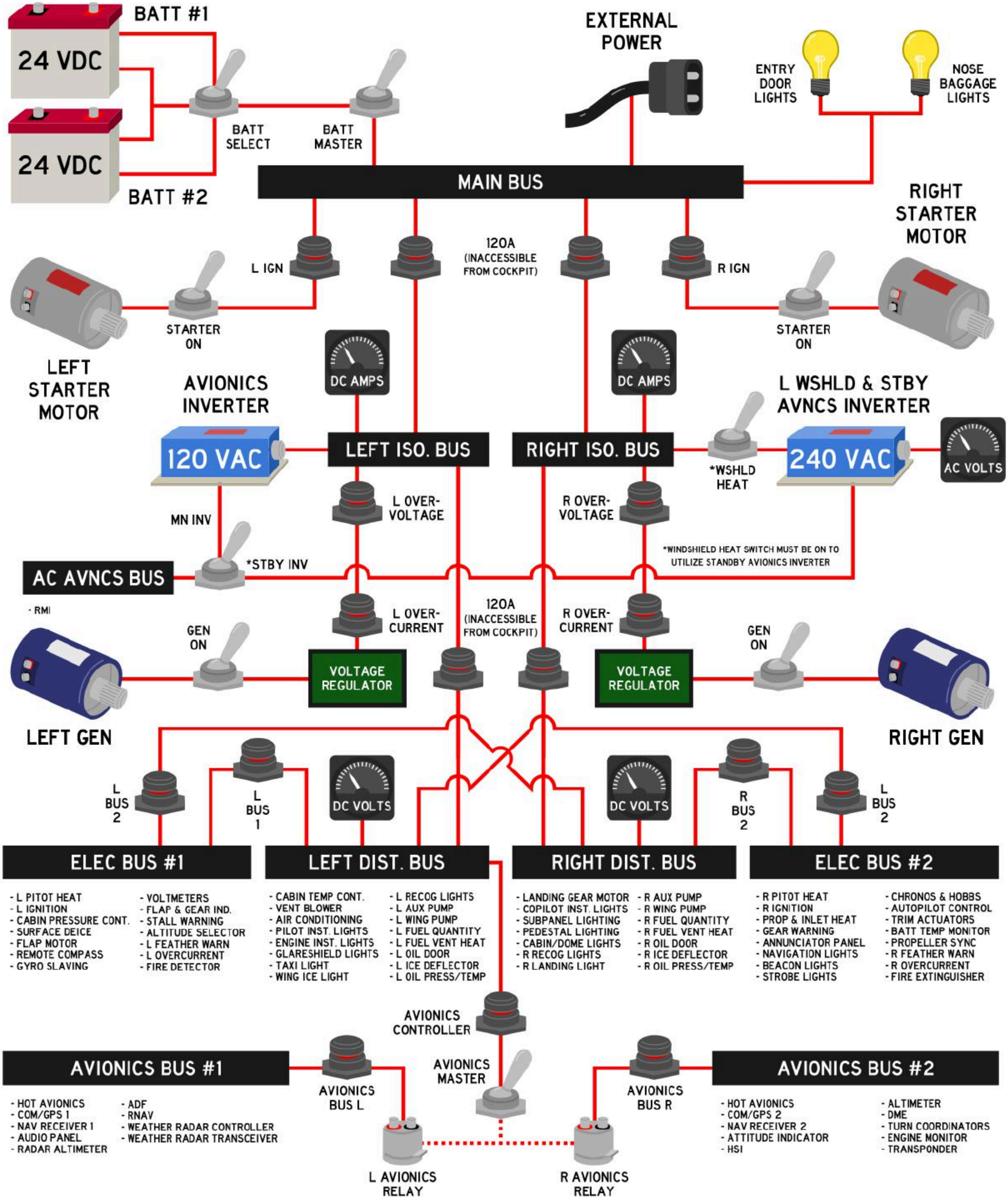
Dual battery system

The Turbine Duke comes equipped with two batteries, as opposed to the Piston Duke's one, and a three position switch on the pilot's upper side panel to select which ones are used to power the aircraft. All normal operations should be conducted with the switch in the BOTH position; however, the checklists end with selecting a single battery. This is a convenience recommendation that will result in the operator always having a charged battery to start an engine with if a cockpit light or master switch was left on while away from the aircraft.

Overview Electrical Schematic

The Turbine Duke's electrical system is significantly more complex than other light twin engine aircraft, more closely resembling that of many twin turboprop aircraft. Of particular note is the ability to isolate many loads in the event of a failure, and the automatic isolation of a generator bus in the event of an overvoltage detection. The Turbine Duke also possesses two alternating current inverters, one for each isolation bus. The main inverter, labeled "MN INV" on the pilot's upper side panel, provides AC avionics power, while the standby inverter provides power for the heated windshield. The standby inverter can be used to power the AC avionics in an emergency by placing the avionics power inverter switch in the "STBY INV" position, and turning on the "WSHIELD HEAT" switch.

NOTE: The aircraft's electrical system can be monitored via the electrical page of the tablet interface, where a schematic nearly identical to this one is presented. For more information on the tablet's engine pages, see the "Live Schematic Page" section of this manual.



BATT #1
24 VDC
24 VDC
BATT #2
BATT SELECT
BATT MASTER
EXTERNAL POWER
ENTRY DOOR LIGHTS
NOSE BAGGAGE LIGHTS
MAIN BUS
RIGHT STARTER MOTOR
L IGN
120A (INACCESSIBLE FROM COCKPIT)
R IGN
STARTER ON
STARTER ON
LEFT STARTER MOTOR
DC AMPS
DC AMPS
AVIONICS INVERTER
L WSHLD & STBY AVNCS INVERTER
120 VAC
LEFT ISO. BUS
RIGHT ISO. BUS
*WSHLD HEAT
240 VAC
AC VOLTS
MN INV
L OVER-VOLTAGE
R OVER-VOLTAGE
*WINDSHIELD HEAT SWITCH MUST BE ON TO UTILIZE STANDBY AVIONICS INVERTER
AC AVNCS BUS
*STBY INV
- RMI
GEN ON
L OVER-CURRENT
120A (INACCESSIBLE FROM COCKPIT)
R OVER-CURRENT
GEN ON
VOLTAGE REGULATOR
VOLTAGE REGULATOR
LEFT GEN
RIGHT GEN
L BUS 2
L BUS 1
DC VOLTS
DC VOLTS
R BUS 2
L BUS 2
ELEC BUS #1
- L PITOT HEAT
- L IGNITION
- CABIN PRESSURE CONT.
- SURFACE DEICE
- FLAP MOTOR
- REMOTE COMPASS
- GYRO SLAVING
- VOLTMETERS
- FLAP & GEAR IND.
- STALL WARNING
- ALTITUDE SELECTOR
- L FEATHER WARN
- L OVERCURRENT
- FIRE DETECTOR
LEFT DIST. BUS
- CABIN TEMP CONT.
- VENT BLOWER
- AIR CONDITIONING
- PILOT INST. LIGHTS
- ENGINE INST. LIGHTS
- GLARESHIELD LIGHTS
- TAXI LIGHT
- WING ICE LIGHT
- L RECOG LIGHTS
- L AUX PUMP
- L WING PUMP
- L FUEL QUANTITY
- L FUEL VENT HEAT
- L OIL DOOR
- L ICE DEFLECTOR
- L OIL PRESS/TEMP
RIGHT DIST. BUS
- LANDING GEAR MOTOR
- COPILOT INST. LIGHTS
- SUBPANEL LIGHTING
- PEDESTAL LIGHTING
- CABIN/DOME LIGHTS
- R RECOG LIGHTS
- R LANDING LIGHT
- R AUX PUMP
- R WING PUMP
- R FUEL QUANTITY
- R FUEL VENT HEAT
- R OIL DOOR
- R ICE DEFLECTOR
- R OIL PRESS/TEMP
ELEC BUS #2
- R PITOT HEAT
- R IGNITION
- PROP & INLET HEAT
- GEAR WARNING
- ANNUNCIATOR PANEL
- NAVIGATION LIGHTS
- BEACON LIGHTS
- STROBE LIGHTS
- CHRONOS & HOBBS
- AUTOPILOT CONTROL
- TRIM ACTUATORS
- BATT TEMP MONITOR
- PROPELLER SYNC
- R FEATHER WARN
- R OVERCURRENT
- FIRE EXTINGUISHER
AVIONICS CONTROLLER
AVIONICS BUS #1
- HOT AVIONICS
- COM/GPS 1
- NAV RECEIVER 1
- AUDIO PANEL
- RADAR ALTIMETER
- ADF
- RNAV
- WEATHER RADAR CONTROLLER
- WEATHER RADAR TRANSCEIVER
AVIONICS BUS L
AVIONICS MASTER
AVIONICS BUS R
AVIONICS BUS #2
- HOT AVIONICS
- COM/GPS 2
- NAV RECEIVER 2
- ATTITUDE INDICATOR
- HSI
- ALTIMETER
- DME
- TURN COORDINATORS
- ENGINE MONITOR
- TRANSPONDER
L AVIONICS RELAY
R AVIONICS RELAY

Using the KNS-81 RNAV Navigation System

The Concept

When most pilots hear the acronym "RNAV", they probably think of the modern RNAV, or GPS approach type, or precision enroute navigation for airliners; however, long before this type of navigation, there was the onboard RNAV computer. This 1980's era piece of early digital computer technology allowed pilots to fly complex routes with precision away from traditional ground-based radionavigation sources, such as VOR's and NDB's, and fly much shorter routes as a result. As the technology improved, even an early form of RNAV approaches became possible. Before GPS, the onboard RNAV computer allowed for GPS-like flying in a sophisticated package of digital electronics, marketed towards small to mid-size general aviation aircraft.

How it Works

To understand how the RNAV computer works, consider the utility of being able to place a ground-based VOR antenna anywhere you like along your route. If your destination airport does not have a radionavigation source on the field, you could simply place one there, and fly directly to or from it. You could also place an antenna 10 miles out from a runway to set up for a non-precision approach. You could even place an antenna on the threshold of a runway, set your HSI course to the runway heading, and fly right down to the runway with lateral guidance; in fact, this is how an ILS receiver works. The KNS-81 Navigation System allows the user to "move" a virtual VOR antenna anywhere they like within the service volume (area of reliable reception) of an existing VOR antenna.

"Moving" a VOR

To "move" a VOR antenna to somewhere useful, we must know how far from the tuned VOR station we would like to move it, and in what direction. These quantities are defined by a nautical mile distance, and a radial upon which we would like to move the antenna. For example, to place a virtual VOR 10 miles to the Southwest of an existing station, we would need to enter the station's frequency, a displacement radial of 225°, and a displacement distance of 10.0 nm. Once we have entered this data into the RNAV computer, the resulting reading from this new virtual VOR station will be indicated on our HSI in the same manner as any other VOR, assuming the HSI source selector switch is set to “RNAV”, and not “NAV1”. This means that you can rotate the course select adjustment knob to any position you like, to fly to/from from the new virtual station on any radial or bearing, so long as you stay within the service volume of the tuned VOR station.

Data Entry

Now that you understand the basics of RNAV navigation, let's learn how to enter the data from above into the KNS-81. On the right side of the unit, you will find the “DATA” push button, and the adjacent data entry knob. Along the bottom of the display, “FREQ”, “RAD”, and “DST”, annunciators remind you of the order in which data should be entered, frequency first, then radial, and finally distance. At any given time, one of these annunciators is bracketed to indicate which type of data is being entered. Press the “DATA” push button to cycle through the data entry process, and use the data entry knob to tune a frequency, enter a radial, and finally a distance.

Data Storage Bins

On the left of the display, a 7-segment display marked “WPT” indicates the current RNAV waypoint for which data is being shown and edited on the right of the display. The KNS-81 can hold up to ten different combinations of frequency, radial, and distance data at one time. This can be greatly useful while planning a flight on the ground. To cycle through waypoints, rotate the inner knob of the dual concentric rotary encoder on the left of the unit’s face. The active waypoint currently being used by the computer and subsequently displayed on the HSI and DME instruments can be selected by pressing the “USE” button while the desired waypoint is being displayed. Whenever the currently displayed waypoint is different from the currently active waypoint, the number of the currently displayed waypoint will flash continuously.

Distance Measuring Equipment

Most notably different than this unit’s predecessor unit, the KNS-80, is the lack of integrated DME information. The KNS-81 was designed to be used as a secondary, or tertiary navigation radio with an external DME display installed elsewhere on the panel. In this case, a KDI-572R fulfills this role. The KDI-572R is a traditional Distance Measuring Equipment (DME) display, with an extra rotary selector position to display RNAV information. See this manual’s section on the KDI-572 for complete information on operation. It should be noted that, like all other DME displays, this one is similarly dependent on being within the VOR service volume, and having good line-of-sight reception of the station. It should also be noted that these distances, speeds, and times, are based on slant-range to the station, not distance along the ground, as one would draw on a map. For most procedures, it was determined that this fact did not make such a large difference as to be detrimental to the procedure, but pilots should still be aware of the distinction. The KNS-81 also possesses a “RAD” toggling push button, which will force the DME display to indicate the current radial upon which the aircraft sits, relative to the waypoint.

Modes of Operation

Lastly, on the left side of the display, the KNS-81's many modes are annunciated. The KNS-81's modes fall into two categories; VOR and RNAV, and are activated by rotating the outer dual concentric knob on the left of the unit's face. The VOR modes allow for the driving of an HSI with traditional VOR and ILS (including glideslope) data from the unit's third VHF navigation receiver. The VOR mode allows for behavior identical to a standard VOR receiver, with 10° of full-scale deflection to either side of the HSI's course deviation indicator (CDI). The PAR mode, which puts the CDI in a "PARallel" mode of operation, and linearizes the course deviation to +/- 5 nm full-scale deflection. This can be useful for tracking airways more accurately. In the two RNAV modes, CDI deflection is based on the displaced virtual VOR of the currently active waypoint. There are two RNAV modes, "RNV/ENR" (Enroute), which drives the CDI with linear deflections of +/- 5 nm full-scale, and "RNV/APR" (Approach), which drives the CDI with linear deflections of +/- 1.25 nm full-scale. Lastly, the KNS-81 has a momentary display mode, which can be activated by holding the "CHK" push button. This mode will display the aircraft's current position relative to the tuned physical VOR station. Pressing the "RTN" button will return the data displays to the active waypoint being used for navigation.

Modes in Summary:

VOR: Angular course deviation, 10° full-scale deflection, just like a third NAV radio.
VOR/PAR: Linear course deviation, 5 nm full-scale deflection, useful for existing airways.

RNV: Linear course deviation, 5 nm full-scale deflection, displaced VOR waypoints.
RNV/APR: Linear course deviation, 1.25 nm full-scale deflection, displaced VOR waypoints.

Other Possible Uses

Another possible use for the RNAV Navigation System is simply determining your distance away from an arbitrary point within a VOR service volume. This can be useful for many applications, such as ensuring that you remain clear of controlled airspace, or a temporary flight restriction (TFR). It could also be used for maintaining a certain distance away from a coastline, or flying circles around a target on the ground. A further possible use for the RNAV Computer is enhanced VOR "Fencing", such as for avoiding special use airspace, military operations areas, international airspace borders, or Air Defense Identification Zones (ADIZ), or descent planning, or radionavigation switchover points. Finally, one of the most useful applications of the RNAV System is in establishing holding patterns. Before GPS, holding pattern entry and flight could be even more confusing than it already is today. With an RNAV computer, a holding point entry waypoint can be placed anywhere, and flown around like there is a purpose-placed ground-based transmitter at the entry point.

Flying an RNAV Course with the Autopilot

The autopilot will only use the KNS-81 as a navigation source when the no-GPS avionics configuration is selected from the tablet interface. Press the navigation source button to illuminate its "RNAV" annunciator. Use the toggle switch above the attitude indicator to select "RNAV" as the HSI source. Then, select the desired course with the HSI's course select knob.

Recommended Skills

1. Direct Route Navigation
2. Parallel Flight along Airways
3. Location & Distance from Waypoints
4. Enhanced Geo-Fencing
5. Maintaining Distance from Ground Points
6. Holding Pattern Entries
7. Fly a Rectangular Course

Direct Flight to Airport Tutorial

Lastly, as a first illustration of the power within the RNAV navigator, follow these steps to fly from any location within the chosen VOR service volume directly to an airport of your choosing without the need for any colocated navigational aid.

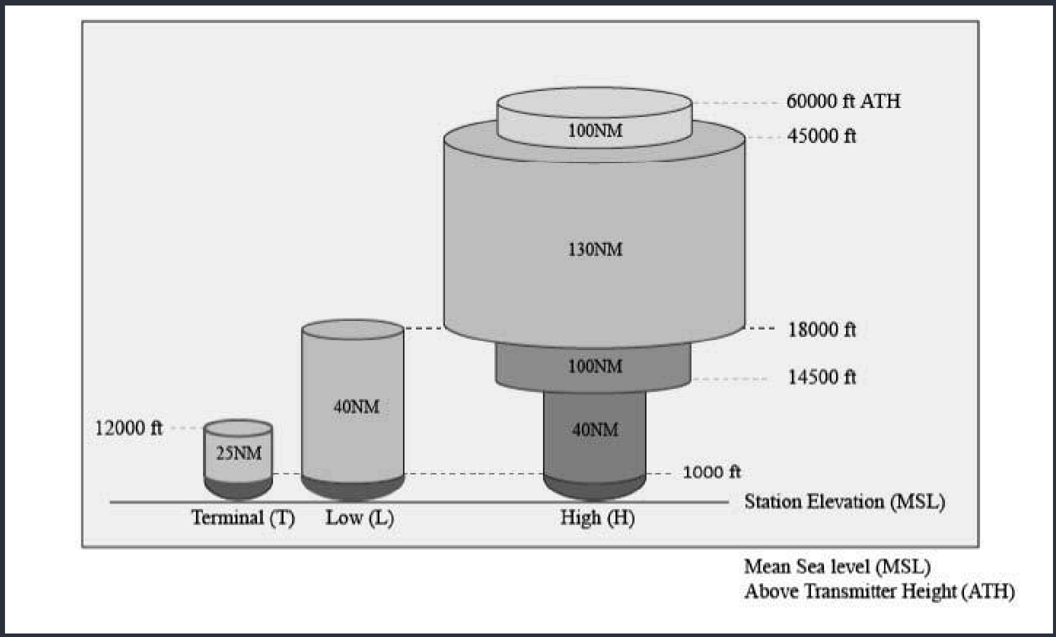
1. Locate the nearest VOR station to your desired destination, and its frequency, radial, and distance from the destination airport. While other station frequencies, radials, and distances can be found on approach, arrival, and departure charts, the easiest place to start is often with a mobile app or website that lists nearby stations along with other airport information. Examples include: ForeFlight, Garmin Pilot, FltPlan Go, SkyVector.com, and Airnav.com. These radials and distances can also be calculated during preflight planning by hand with a plotter, or with most flight planning software applications. In this case, we will use SkyVector.com to search for a destination airport, in this case, Beverly Airport in the US state of Massachustts.

Nearby Navigation Aids

ID	Name	Freq	Radial / Range		ID	Name	Freq	Bearing / Range	
LWM	LAWRENCE	112.50	154°	12.3	**OW**	STOGE	397	198°	29.4
BOS	BOSTON	112.70	029°	14.0	**MJ**	FITZY	209	302°	31.9
NZW	SOUTH WEYMOUTH	133.40	017°	26.1	**ESG**	ROLLINS	260	005°	38.4
MHT	MANCHESTER	114.40	145°	26.3	**CO**	EPSOM	216	323°	39.9

In the fourth block of data, we are presented with four nearby VOR stations (on the left), all providing good coverage to Beverly Airport. To assess whether or not a VOR provides good service to your destination, reference the following chart for VOR service volumes published by the Federal Aviation Administration. For the vast majority of VOR stations, reception will be acceptable within 40 nm of the station while in-flight, and is usually the only volume worth considering for low altitude general aviation flights.

For this example, we will choose the nearest VOR at Lawrence Airport, (LWM). This VOR has a frequency of 112.50 Mhz, a radial to Beverly Airport of 154°, and a distance of 12.3 nm. These are all three pieces of data that we need to fly directly to Beverly.



2. Enter the three pieces of data we located above into the KNS-81 RNAV computer. Once the KNS-81 is powered on, all your data entered during previous flights will be loaded from memory, and the active “display”, and “use” data channels will be set to 1, and 1. First, we will use the dual concentric rotary knobs on the right of the unit to enter the frequency 112.5 Mhz into data channel 1, just as we would with any other navigation radio.

3. Once our desired frequency has been set we will use the "DATA" push button to page through the three required pieces of data in this data channel in the order "FREQ", "RAD", and "DST". Press the "DATA" button once, and then enter the radial 154.0, again with the dual concentric rotary knobs. Should your desired radial include a decimal component, the inner rotary knob can be pulled and rotated for decimal entry.

4. When our desired radial is set, press the "DATA" push button once again to enter our desired distance offset of 12.3 nm. Again, should your desired distance include a decimal component, the inner rotary knob can be pulled and rotated for decimal entry.

5. Data entry is now complete; however, before we can begin following the CDI to the airport, we need to choose an RNAV mode of operation, probably RNV/ENR for enroute operation, unless we need increased precision for some reason. Rotate the outer dual concentric rotary encoder on the left of the unit's face until only "RNV" is annunciated above the knob. In RNAV modes of operation, our CDI will guide us to the displaced VOR waypoint at Beverly Airport that we just created, and all displayed DME information will be relative to that new waypoint

NOTE: VOR modes of operation WILL NOT provide CDI or DME information relative to the active waypoint. They are for operation as a conventional navigation radio with reference to existing VOR stations, in either angular or linear course deviation mode.

6. Lastly, make sure the HSI SOURCE switch in your aircraft is set to RNAV; otherwise, we will not see the RNAV information displayed on the HSI.

7. To fly directly to the displaced VOR waypoint at our destination airport, simply rotate the omni-bearing selector (OBS) or course (CRS) knob on your HSI, as you would to fly to a VOR, and follow the CDI needle with a TO indication. Countdown the distance and time remaining until arriving at your destination on the external DME instrument. When you have arrived, the TO/FROM indication will reverse, and DME distance will approach zero, just like with a conventional VOR receiver. Even at distances of 40 nm away from the actual VOR station, this system is usually precise enough to place your route of flight inside the airport perimeter fence at your destination.

8. To check your position relative to the actual VOR station you are receiving at any given time, press and hold the “CHK” button. The RAD and DST displays will now indicator your actual distance from the VOR station, and the radial upon which the aircraft sits. Release the “CHK” button to return to viewing RNAV information appropriate to the currently selected mode of operation.

Using the ETM Engine Trend Monitor

The Turbine Duke is equipped with the first and most complete implementation of the ETM engine trend monitor to appear in a flight simulator. The ETM is a common piece of engine monitoring equipment found in general aviation turbine engine aircraft, and is often underestimated in its power and utility due to its compact size. Aircraft owners would be wise to fully understand the information at their fingertips via the unit's trend monitoring to increase engine longevity and detect changes that may result in a catastrophic failure. Due to the cost and relative fragility of turboprop engines, operators keep a close watch on recorded engine parameters. Exceedance alarms alert pilots to dangerous conditions, and realtime information on engine performance provides a means to increase fuel efficiency and reduce wear. For a complete understanding of the unit's functionality, please see the "More Information on Operation" section of this manual for real world operating resources.

The ETM's interface is divided into four "Files" with an arbitrary number of "Pages" in each file. The files are selected with the rotary knob, and pages with the "PAGE UP/DOWN" toggle switch. Some pages have additional subpages, which are selected from with the "INCR/DECR" toggle switch. When power is applied to the unit, a self-test is initiated while the current software version, data version, aircraft model number, and company information is shown.

ETM File - Engine Trend Monitor

Page Name	Example	Description
NG & ITT	NG% 98.4 ITT 746	Gas Generator RPM % Interstage Turbine Temperature °C
TQ & ITT	TQ 1124 ITT 728	Propeller Torque in FT-LBS Interstage Turbine Temperature °C
Prop & NG	NG% 98.4 NP 746	Gas Generator RPM % Propeller RPM
SHP	SHAFT HP: 955	Derived Shaft Horsepower HP = Tq * RPM / 5252
Specific Fuel	SFC: 0.452	Pounds of fuel consumed to produce one shaft horsepower - engine efficiency
Key Status	Key 21.4%used Status: Init	Amount of data used on USB data stick
Log of Totals, Title Page	LOG OF TOTALS	Use INCR/DECR toggle switch to select sub-page.
Total Cycles, Total Flight Time	AF TC/TT 825/1285:15	Total takeoff/landing cycles of the airframe/ Total hours and minutes of flight time
Engine Total Starts, Engine Total Time	Eng TS/TT 858/1498:58	Total engine start/shutdown cycles/ Total hours and minutes of engine run time
Lowest Voltage Highest ITT	LoV|Hi ITT 18.8 821	Lowest voltage and highest ITT during start Symbols: - = stopped, / = starting, | = running
Next Inspection	Inspection Due 72:34:12	Time until regular inspection Interval set by maintenance technician

NAV File - Navigation Data

Page Name	Example	Description
Current GPS Position	Pos N 45°23.2 W081°10.8	*Current GPS longitude and latitude
ETE Next Waypoint	To BOSOX ETE 24.7nm 00:08	*Identifier, distance, and time-to-go (HH:MM) for the next waypoint in the flightplan
ETA Next Waypoint	ETA > BOSOX 17:35 LCL	*Estimated time of arrival in local time at the next waypoint in the flightplan
ETE Last Waypoint	To Dest. ETE 410.7nm 02:35	*Distance and time-to-go (HH:MM) for the last waypoint in the flightplan
ETA Last Waypoint	ETA > Dest. 01:20 LCL	*Estimated time of arrival in local time at the last waypoint in the flightplan
Track & Groundspeed	MTrk098 Var GS292kt W13.8	*Magnetic track and groundspeed of the aircraft, and magnetic variation in the area
Wind Speed & Direction	Wind/Drift 072/18kt 07R	*Current wind direction from and speed based on the GPS drift angle of the aircraft
Heading & Drift Angle	Headng/Drift 321/ 9L"	*Current heading and drift angle of the aircraft based on GPS track
Heading & Turn Rate	Heading/ ROT 135/ -05.8	Current heading and rate of turn of the aircraft

*A hot-swapping radio configuration with a GPS must be active for these pages to display data.

FUEL File - Fuel Flight Planning Data

Page Name	Example	Description
Full Fuel	Full Fuel 290.6GL	Full fuel payload of the aircraft in gallons
Fuel Required to Last Waypoint	Fuel to KTPA 84.9 GAL	*Fuel required to reach the last waypoint in the flightplan at current consumption rate
Fuel at Last Waypoint	Fuel at KTPA 42.7 GAL	*Fuel remaining at the last waypoint in the flightplan at current consumption rate
Specific Range	Specfic Range 2.12NM/GAL	*GPS groundspeed divided by fuel consumption in GPH - flight efficiency
Fuel Flow	F/Flow GPH 45.6	Fuel flow in gallons per hour
Fuel Used & Fuel Remaining	F/Use 24.8GL F/Rem 107.4GL	Fuel used since power was applied to the ETM unit, and fuel remaining in gallons
Endurance	T/Rem 01:40HR F/Use 24.8GL	Time remaining until empty at current rate of consumption, and fuel used in gallons

*A hot-swapping radio configuration with a GPS must be active for these pages to display data.

AIRDATA File - Aircraft Sensor & Flight Data

Page Name	Example	Description
Local Date & Time	THU 6 JUL23 08:17:43 EST	Current local date and time
Universal Time	TIME 12:17:43 GMT	Current Greenwich Mean Time
Flight Timer	FLIGHT TIMER 02:10:35	Time elapsed since airspeed exceeded the takeoff threshold set by maintenance
OAT & Density Altitude	OAT D.ALT -08C 10800	Outside air temperature in °C, and calculated density altitude in feet
Pressure Altitude & Density Altitude	P.ALTft D.ALT 16000 18400	Pressure altitude, and calculated density altitude in feet
IAS, TAS, MACH	IAS TAS MACH 184kt220 0.291	Indicated airspeed, calculated true airspeed, and calculated mach number
Gross Weight	Gross Weight 6145LB	Current calculated gross weight of the aircraft, accounting for fuel burned

Alarms

The ETM is constantly monitoring all available engine and fuel flow parameters, and will activate an alarm to warn the operator of a potentially dangerous situation. When an alarm is activated, regardless of the current operational mode, the data display will show one of the alarm codes and associated values enumerated below, and blink while the exceedance is occurring. To cancel the active alarm press the ENTER button, or use the PAGE UP/DOWN switch. Since many simultaneous alarm conditions may exist at once, each alarm has a priority, allowing the most severe condition to be displayed first. The following list of alarm codes is listed in priority order, with the most severe condition listed first.

Description	Example	High Limit
High Interstage Turbine Temp	Exceedance ITT 921	805 °C (Normal) 1,090 °C (Starting)
High Propeller Torque	Exceedance TQ 1971	1,260 FT-LBS
High Gas Generator RPM	Exceedance NG 107.2	102.0%
High Propeller RPM	Exceedance NP 2552	2,400 RPM

Stopwatch

The ETM possesses a stopwatch, which can be accessed from any mode via the "CLOCK" controls on the right of the unit. In this mode, the words "STOP WATCH" will appear at the top of the display, with hours, minutes, and seconds elapsed below. The START/STOP switch is used to start and stop counting. The RESET button will stop and reset the time to all zeros.

Normal Checklists

Preflight (Cockpit)

Preflight Inspection	Complete
Control Locks	Remove
Seats & Seatbelts	Secure
Cabin Door	Latched
Nose Baggage Door	Latched
Parking Brake	Set
Landing Gear	Down
Electrical Switches	Off
Engine & Avionics Switches	Off
Oxygen Pressure	1550-1850 psi
Circuit Breakers	All In
Supplemental Bleed Air	Off (Push)
Cabin Press Shutoff	Open (Push)
Alternate Static Air	Normal
CO Detector	Test
Environmental Mode	Off
Flaps	Up
Power Levers	Flight Idle
Propellers	High RPM
Condition Levers	Cut-Off
Trims	Centered
Fuel Selectors	On

Before Starting Engine

Beacon Light	On
Battery Master	On
Fuel Quantities	Check
Annunciators	Test & Consider
Battery Selector	#1
Bus Volts	23V Minimum
Battery Selector	#2
Bus Volts	23V Minimum
Battery Selector	Both
L Ignition	Check Auto then On
R Ignition	Check Auto then On
L Wing Pump	Check then Off
R Wing Pump	Check then Off
L Aux Pump	Check then Off
R Aux Pump	Check then Off

Engine Start

R Starter	On
Bus Volts	15V Minimum
Gas Generator	15% Minimum
Condition Lever	Run
ITT	Less than 1090C
R Starter	Off at 52% Ng
R Ignition	Off
Engine Instruments	Check
R Generator	On
R Generator Load	Below 60 in 2min
Bus Volts	28V
Battery Temperature	Below 120F
L Starter	On
Bus Volts	15V Minimum
Gas Generator	15% Minimum
Condition Lever	Run
ITT	Less than 1090C
L Starter	Off at 52% Ng
L Ignition	Off
Engine Instruments	Check
L Generator	On
L Generator Load	Below 60 in 2min
Bus Volts	28V
Battery Temperature	Below 140F

After Starting

Lights	As Required
Weather Radar	Off/Standby
Avionics	On
Inverter	Main
INVTR FAIL Annun	Extinguished
Cabin Temp & Mode	As Desired
Parking Brake	Release
Brakes	Check

Runup

Parking Brake	Set
Annunciators	Test & Consider
Remote Compass	Slaved & Aligned
Fuel Selectors	Crossfeed
Wing Pumps	On
Power Levers	2050 RPM
Prop Gov Test	2000 RPM
Power Levers	2190 RPM
Exercise Left Propeller	To 1500 RPM
Exercise Right Propeller	To 1500 RPM
Fire Detector	Test
Left Generator	Hold Reset
Left Generator Load	Zero
Right Generator	Hold Reset
Right Generator Load	Zero
Gen. Load Sharing	~40A Total, +/- 2A/Side
Power Levers	Idle
Oil Doors	Open
Ice Deflectors	On
Instrument Air	Green & No Lights
Cockpit Window	Closed
Cabin Altitude	Field Elevation
Cabin Differential	Zero
Cabin Climb Rate	10 O'Clock
Cabin Altitude Goal	1000ft below field elev.
Cabin Press Mode	Test
Cabin Alt, Diff & Climb	Observe Descent

Cabin Altitude Goal	Set First Assigned Alt
Cabin Press Mode	NORmal
ICE DR ON Annun	Both On
Ice Deflectors	As Required
Propeller Heat	On
Prop Heat Gnd Test	Hold
Propeller Amps	14-28A & Cycles
Propeller Heat	Off
Windshield Heat	On
Windshield Volts	220-260V
Ammeters	Increase
Windshield Heat	Off
Left Pitot Heat	On
Ammeters	Increase
Right Pitot Heat	On
Ammeters	Increase
L Fuel Vent Heat	On
Ammeters	Increase
R Fuel Vent Heat	On
Ammeters	Increase
Heating Switches	Off
Surface Deice	Manual
Boot Pressure	15-20 psi
Surface Deice	Single Cycle
Boot Pressure	15-20 psi
Surface Deice	Off

Fuel Selectors	On
Pitch Trim Power	On
Electric Trim	Exercise
Autopilot	Test
Heading Bug	30 Degrees Left
Autopilot Master	Engage
Heading Mode	Engage
Yoke Movement	Observe
Flight Director	Bank Left
Heading Bug	30 Degrees Right
Yoke Movement	Observe
Flight Director	Bank Right
Autopilot Disconnect	Press AP Off
Autopilot Disconnect	Press FD Off
Elevator Trim	Set Takeoff

Flaps	Check Operation
Flaps	Set Takeoff
Window	Closed
CABIN DOOR Annun	Extinguished
Ignition	As Required
Flight Controls	Free & Correct
Altimeter	Set
Departure Altitude	Set
Takeoff Heading	Set
Panel Lights	Dim for Takeoff
Parking Brake	Release

Before Takeoff

Oil Temperatures	100F Minimum
Battery Temperature	Below 120F
Air Conditioning	Off
Lighting	As Desired
Transponder	Alt Mode
Weather Radar	On

Takeoff

Power Levers	1260 FT-LBS
Brakes	Release
Engine Instruments	Check
ITT	Less than 805C
Landing Gear Up	Positive Rate
Flaps	Retract at 120kts
Autopilot	Engage
Cabin Alt, Diff & Climb	Observe Climb
Landing Lights	Off

Max Continuous Power

Ignition	Auto/Off
Oil Doors	Open
Propellers	2190 RPM
Power Levers	1260 FT-LBS
Ice Deflectors	As Required
Cabin Temp & Mode	As Desired

Enroute Climb

Propellers	2190 RPM
Power Levers	1200 FT-LBS
Ignition	Auto/Off
Oil Doors	Closed
Ice Deflectors	As Required
Cabin Pressure	Monitor
Cabin Temp & Mode	As Desired
Engine Performance	Monitor

Transition Altitude

Ice Deflectors	As Required
Altimeters	Standard
Cabin Pressure	Monitor
Recog Lights	Off

Cruise

Ignition	Auto/Off
Oil Doors	Closed
Ice Deflectors	As Required
Pitot Heat	On if OAT less than 4C
Windshield Heat	As Required
Propeller Heat	As Required
Surface Deice	As Required
Fuel Imbalance	25 gal Max.
Propellers	2000 RPM
Power Levers	1150 FT-LBS
Cabin Temp & Mode	As Desired
Cabin Pressure	Monitor
Engine Performance	Monitor

Descent

Cabin Altitude Goal	Set Destination Alt
Ignition	Auto/Off
Oil Doors	Closed
Ice Deflectors	As Required
Power Levers	Reduce
Engine Performance	Monitor
Ice Protection	As Required

Approach

Seats & Seatbelts	Secure
Cabin Alt, Diff & Climb	Check Progress
Fuel Selectors	On
Fuel Imbalance	25 gal Max.
Recog Lights	On
Pitot Heat	On if OAT less than 4C
Windshield Heat	Off
Propeller Heat	Off
Cabin Temp & Mode	Off
Ignition	Auto
Ice Deflectors	As Required
Flaps	Approach

Landing

Cabin Differential	Zero
Wing Pumps	On
Propellers	2190 RPM
Oil Doors	Open
Flaps	As Required
Landing Gear	Down & Locked
Landing Lights	On
Autopilot Disconnect	Press Once

Balked Landing

Propellers	2190 RPM
Power Levers	1260 FT-LBS
Engine Instruments	Check
Landing Gear Up	Positive Rate
Flaps	Retract at 120kts

After Landing

Ignition	Off
Oil Doors	Closed
Ice Deflectors	As Required
Flaps	Up
Cabin Alt, Diff & Climb	Verify Zero
Cabin Press Mode	Dump
Weather Radar	Off/Standby
Lights	As Desired
Ice Protection	All Off
Cabin Temp & Mode	As Desired

Shutdown & Securing

Parking Brake	Set
Avionics Switches	Off
Electrical Switches	Off
Generators	Off
Power Levers	Idle
Propellers	Feather
Condition Levers	Cut-Off
Wing Pumps	Off when Ng below 10%
Battery Master	Off
Battery Selector	#1
Parking Brake	Release
Control Locks	Install

Instrument Markings & Colors

Engine Torque:

0-1,200 FT-LBS (GREEN)
1,200-1,260 FT-LBS (YELLOW)
1,260 FT-LBS (RED)

Interstage Turbine Temperature:

395-770 °C (GREEN)
770-805 °C (YELLOW)
805 °C (RED)
1,090 °C (RED TRIANGLE)

Gan Generator RPM:

52-101.5 % (GREEN)
101.5 % (RED)

Propeller RPM:

450-1,600 RPM (YELLOW)
1,260-1,600 RPM (GREEN)
1,600-1,800 RPM (YELLOW)
1,800-2,190 RPM (GREEN)
2,190 RPM (RED LINE)
2,190-2,410 RPM (RED)
2,410 RPM (RED TRIANGLE)

Fuel Pressure:

15-30 PSI (GREEN)

Oil Temperature:

32-50 °F (YELLOW)
50-200 °F (GREEN)
200-210 °F (YELLOW)
210 °F (RED)

Oil Pressure:
40 psi (RED)
40-80 psi (YELLOW)
85-105 psi (GREEN)
105 psi (RED)

Vacuum Suction:
2.5-3.5 inHg (YELLOW)
3.5-5.5 inHg (GREEN)
5.5-6.5 inHg (YELLOW)

Main Fuel Quantity:
132.5/130.0 gal (795/780 lbs) (MAXIMUM)
0-25 gal (0-150 lbs) (YELLOW)

Abnormal & Emergency Checklists

Engine Fire (Ground)

Condition Levers	Cut-Off
Ignition	Off
Fuel Selectors	Off
Starters	On for 30s
Observe	If fire continues...
Inop Eng Extinguisher	Identify & Push
Generators	Off
Battery Master	Off

Engine Fire (Flight)

Inop Eng Fuel Selector	Off
Inop Eng Condition	Cut-Off
Inop Eng Generator	Off
Inop Eng Propeller	Feather
Inop Eng Engine	Do Not Restart
Inop Eng Extinguisher	Identify & Push
Inop Eng Cabin Press Shutoff	Pull

Engine Failure (Ground Roll)

Power Levers	Idle
Braking	Maximum
Fuel Selectors	Off
Generators	Off
Battery Master	Off

Engine Failure (Takeoff)

Landing Gear Up	Up
Flaps	Retract above 95kts
Pitch	To Horizon
Bank Towards Op Eng	5 Deg
Inoperative Engine	Identify
Inop Eng Power Lever	Idle
Inop Eng Propeller	Feather
Op Eng Power Lever	1260 FT-LBS
Airspeed	Maintain 120 kts
Inop Eng Condition	Cut-Off
Inop Eng Fuel Selector	Off
Inop Eng Wing Pump	Off
Inop Eng Generator	Off
Op Generator Load	150A Max.

Engine Failure (In Flight)

Airspeed	120 kts
Inoperative Engine	Identify
Inop Eng Power Lever	Idle
Inop Eng Propeller	Feather
Op Eng Power Lever	1200 FT-LBS
Inop Eng Fuel Selector	Off
Inop Eng Wing Pump	Off
Inop Eng Generator	Off
Op Generator Load	150A Max.

Engine Airstart

Inop Eng Fuel Selector	Off
Inop Eng Propeller	Feather
Inop Eng Power Lever	Idle
Inop Eng Wing Pump	On
Inop Eng Fuel Press	5 PSI Minimum
Airspeed	100-198 kts
Altitude	Below 20,000 FT
Inop Eng Ignition	On
Inop Eng Starter	On
Inop Eng Gas Generator	12% Minimum
Inop Eng Condition Lever	Run
Inop Eng ITT	Less than 1090C
Starters	Off at 52% Ng
Ignition	Auto
Engine Instruments	Check
Generators	On
Generator Loads	Below 60 in 2min
Bus Volts	28V
Engine Power	If Not Restored...
Inop Eng Power Lever	Idle
Inop Eng Propeller	Feather
Inop Eng Fuel Selector	Off
Inop Eng Wing Pump	Off
Inop Eng Generator	Off
Op Generator Load	150A Max.
Land	As Soon as Practical

Left Eng Inop Crossfeed

L Fuel Selector	Off
L Wing Pump	On
L Wing Pump	If Inoperative...
R Aux Pump	On
R Fuel Selector	Crossfeed

Right Eng Inop Crossfeed

R Fuel Selector	Off
R Wing Pump	On
R Wing Pump	If Inoperative...
L Aux Pump	On
L Fuel Selector	Crossfeed

Engine Clearing

Propellers	Feather
Condition Levers	Cut-Off
Power Levers	Idle
Ignition	Off
Starters	On for 30s

Emergency Descent

Power Levers	Idle
Propellers	2190 RPM
Landing Gear	Down
Flaps	Approach
Airspeed	175 kts

Maximum Glide

Landing Gear	Up
Flaps	Up
Propellers	Feathered
Airspeed	110 kts
Cabin Temp & Mode	Off
Nonessential Equipment	Off
Engine & Avionics Switches	Off
Fuel Selectors	Off

Electrical Smoke or Fire

Generators	Off
Battery Master	Off
Window	Open if Unpressurized
Avionics Switches	Off
Cabin Temp & Mode	Off
Electrical Equipment	Off
Cabin Air & Heat	Off
Observe	If No Fire...
Battery Master	On
Restore Essential Power	Circuit by Circuit
Avionics Switches	On
Restore Avionics Power	Circuit by Circuit

High Pressure Differential

CABIN DIFF Annun	If Illuminated...
Cabin Altitude Goal	Set Higher Altitude
Cabin Climb	If No Descent...
Cabin Press Shutoff	Pull
Cabin Press Mode	Dump
Differential Press	Green
Cabin Press Mode	NORmal
Cabin Press Shutoff	Push

Cabin Depressurization

CABIN ALT Annun	If Illuminated...
Emergency Descent	Begin
Cabin Press Mode	Test
Cabin Climb	If no Descent Observed...
Pressurization Circuit Breakers Check/Reset	
Cabin Press Mode	Test
Cabin Climb	If no Descent Observed...
Cabin Press Shutoff	Pull

Carbon Monoxide Detected

Cabin Temp & Mode	Off
Cabin Air & Heat	Off
CO Detector	Reset
CO Alarm	If Persists...
Cabin Press Shutoff	Pull
CO Alarm	If Persists...
Power Levers	Idle
Propellers	Feather
Condition Levers	Cut-Off
Window	Open if Unpressurized
Cabin Air	On
Nonessential Equipment	Off

Generator Failure

Generator Load	Verify No Load
Inop Eng Generator	Reset
Inop Eng Generator Load	If No Load...
Inop Eng Generator	Off then On
Inop Eng Generator Load	If No Load...
Inop Eng Generator	Off
Op Generator Load	150A Max.
Generator Load	If Dual Failure...
Nonessential Equipment	Off
Land	As Soon as Practical

Starter Does Not Disengage

Generators	Off
Battery Master	Off
Condition Levers	Cut-Off

Low Oil Pressure

OIL PRESS Annun	If Illuminated...
Low Oil Press Eng	Identify
Inop Eng Power Lever	Idle
Inop Eng Propeller	Feather
Inop Eng Fuel Selector	Off
Inop Eng Wing Pump	Off
Inop Eng Generator	Off
Op Generator Load	150A Max.
Land	As Soon as Practical

High Oil Temperature

OIL TEMP Annun	If Illuminated...
Oil Door	Open
Power Levers	500 FT-LBS
Land	As Soon as Practical

Fuel Control Failure

Observe	If Producing Power...
Land	As Soon as Practical
Before	Approach...
Inop Fuel Control	Identify
Inop Eng Power Lever	Idle
Inop Eng Propeller	Feather
Inop Eng Fuel Selector	Off
Inop Eng Wing Pump	Off
Inop Eng Generator	Off
Op Generator Load	150A Max.

Engine Surges

Power Levers	Reduce
Observe	If Surging is Severe...
Surging Engine	Identify
Inop Eng Power Lever	Idle
Inop Eng Propeller	Feather
Inop Eng Fuel Selector	Off
Inop Eng Wing Pump	Off
Inop Eng Generator	Off
Op Generator Load	150A Max.
Land	As Soon as Practical

CHIP DETECTOR Annun Illuminated

Possible Engine Failure	Anticipate
Power Levers	Reduce
Land	As Soon as Practical

FUEL FILTER Annun Illuminated

Fuel Pressures	Compare
Wing or Aux Pumps	On
Fuel Pressures	If Below 12.5 PSI
Land	As Soon as Practical

Low Fuel Pressure

Low Press Eng Aux Pump	On
Fuel Selectors	Check Positions
Fuel Quantities	Check
Fuel Pressure	If Still Low...
Possible Engine Failure	Anticipate
Power Levers	Reduce
Land	As Soon as Practical

Prop Governor Failure

Power Levers	Reduce
Oil Pressure	Check
Exercise Propellers	If No Control...
Airspeed	Reduce
Power Levers	To Maintain RPM
Land	As Soon as Practical

Dual Instrument Air Failure

Instrument Air	Check Sources
DC Instruments	Check & Reference
Land	As Soon as Practical

Static Air Obstructed

Alternate Static Air	Alternate
Airspeed & Altimeter	Apply Corrections

Severe Icing Encounter

Ice Protection	All On
Wing Light	On
Ice Build-Up	Monitor
Propellers	2190 RPM
Ignition	On
Oil Doors	Close
Ice Deflectors	On
Cabin Temp & Mode	Manual Heat
Cabin Air & Heat	On Maximum

Remote Compass Misalignment

Gyro Slave Circuit Breaker	Pull & Reset
Remote Compass Alignment	If Misaligned...
Remote Compass	Free Mode
Compass Position	Push to Align

Autopilot Failure or Trim Runaway

Autopilot	Disconnect
Pitch Trim Power	Off
Autopilot Circuit Breakers	Pull Off

AC Door Fully Extended in Flight

Cabin Temp & Mode	No AC
Increased Drag	Anticipate

Nose Baggage Door Unlatched

Airspeed	Reduce
Cabin Temp & Mode	No Heat
Increased Drag	Anticipate
Land	As Soon as Practical

CABIN DOOR Annun Illuminated

Emergency Descent	Begin
Cabin Pressure	Monitor
When Below	10,000ft...
Airspeed	Reduce
Cabin Press Shutoff	Pull
Increased Drag	Anticipate
Land	As Soon as Practical

Landing Gear Manual Extension

Airspeed	174 kts or Less
Landing Gear Relay	Pull Off
Landing Gear	Handle Down
Emergency Gear Handle	Engage
Crank Handle	50 Turns
Gear Warning	Push On
Gear Indicators	Three Green

Landing Gear Up after Man Ext

Landing Gear Relay	Push On
Landing Gear	Handle Up

Simulated Engine Out

Propeller	2190 RPM
Power Levers	100 FT-LBS

Flap Failure

Flap Breakers	Check On
Bus Volts	23V Minimum
Flaps	As Required
Flap Indicators	Check
Flaps	Visually Check

No Power Landing

Fuel Selectors	Off
Condition Levers	Cut-Off
Flaps	As Required
Landing Gear	Down & Locked
Generators	Off
Battery Master	Off

Cabin Door Will Not Open

Cabin Door Handle	Pull Firmly
Cabin Alt, Diff & Climb	Verify Zero
Cabin Press Mode	Dump
Cabin Door Handle	If still stuck…
Door Pressure Bypass	Pull
Cabin Door Handle	Pull Firmly

More Information on Operation

Black Square aircraft are created by an avid pilot who believes that every switch, knob, and button should be interactable, and the user should be able to follow real world procedures without compromising results from the simulation. This aircraft was designed and tested using real world handbooks and procedures, and leaves little to the imagination in terms of functionality. For the most immersive experience, it's recommended that you seek out manuals, handbooks, checklists, and performance charts from the real aircraft represented in this simulation. Although this aircraft and simulation is not suitable for real world training, and should not be used for such, every effort has been taken to ensure that the simulation will represent the real aircraft until the fringe cases of instrument flying, or system failure.

In the case of this particular product, featuring the KNS-81 Navigation System, and the RDR 1150XL, additional resources are available online for the real world counterparts of these units. In particular the **"KNS-81 Pilot's Guide"**, available on Bendix/King's website, and the **"Weather Radar Pilot Training DVD"** on Bendix/King's YouTube channel. A complete **"Pilot's Operation Manual" to the ETM Engine Trend Monitor** can be found on the Shadin Avionics website. Additionally, the **"KLN-90B Pilot's Guide"** is also available on Bendix/King's website.

Hardware Inputs & Outputs

A nearly complete list of input and output variables and events is provided below for home cockpit builders. If this list is not enough to accomplish the amount of interactivity you are looking to achieve in your home cockpit, anything is possible with a little code. Nothing in any Black Square aircraft is "hard coded", or made inaccessible behind encrypted or compiled files. If you have further questions, contact Just Flight Support, or reach out to me directly in the Just Flight Community forums, where I will be happy to help.

Inputs

Exterior & Cabin Element Variables

Description	Variable	Range
Throttle Control Locks	L:bksq_throttleLocks	Boolean
Yoke Control Locks	L:bksq_controlLocks	Boolean
Pitot Covers	L:bksq_PitotCovers	Boolean
Engine Covers	L:bksq_EngineCovers	Boolean
Tablet Visibility	L:bksq_TabletVisible	Boolean
Tablet Horizontal Position	L:var_efb_rot_x	-1 - 1
Tablet Vertical Position	L:var_efb_rot_y	-1 - 1
Main Cabin Door	L:bksq_CabinDoor	Boolean
Baggage Compartment Door	L:bksq_NoseDoor	Boolean
Pilot’s Window	L:bksq_stormWindow	Boolean
Cabin Door Pressure Bypass	L:var_doorPressureBypass	Boolean
Cabin Table	L:bksq_CabinTable	Boolean
Pilot’s Sun Visor Position	L:var_Visor_L	0 - 100
Copilot’s Sun Visor Position	L:var_Visor_R	0 - 100

Primary Control Variables

Description	**Variable**	**Range**
Condition Lever	B:FUEL_1_Condition_Lever_High_Idle B:FUEL_1_Condition_Lever_Cut_Off L:BKSQ_ConditionLever_1	Boolean
Condition Lever	B:FUEL_2_Condition_Lever_High_Idle B:FUEL_2_Condition_Lever_Cut_Off L:BKSQ_ConditionLever_2	Boolean
Friction Lock (mixture adjust speed)	L:var_FrictionLock	0 - 100
Hide Pilot's Yoke	L:XMLVAR_YokeHidden1	Boolean
Hide Copilot's Yoke	L:XMLVAR_YokeHidden2	Boolean
Control Wheel Steering Yoke Button	L:var_PilotCws	Boolean
Prop Heat Ground Test	L:var_PropHeatGroundTest	Boolean
Windshield Heat	L:var_windshieldHeatSwitch	Boolean
Left Propeller Heat	L:var_PropHeatSwitch_L	Boolean
Right Propeller Heat	L:var_PropHeatSwitch_R	Boolean
Left Fuel Vent Heat	L:var_FuelVentHeatSwitch_L	Boolean
Right Fuel Vent Heat	L:var_FuelVentHeatSwitch_R	Boolean
Surface Deice	L:var_SurfaceDeiceSwitch	0 = AUTO, 2 = MAN
Pitch Trim Power	L:var_PitchTrimPower	Boolean
Annunciator Light Test	L:var_GSA_TestButton	Boolean
Battery Selector Switch	L:var_BatterySelectSwitch	0 = LEFT, 2 = RIGHT
Avionics Inverter Select	L:var_InverterSwitch	0 = MAIN, 2 = STBY
Master Warning Button	L:var_masterWarningLatching	1 = ON, 2 = RESET
Master Caution Button	L:var_masterCautionLatching	1 = ON, 2 = RESET
Left Ignition Switch	L:var_IgnitionSwitch_L	0 = ON, 2 = AUTO
Right Ignition Switch	L:var_IgnitionSwitch_R	0 = ON, 2 = AUTO
Left Generator Reset Button	L:var_GeneratorResetButton_L	Boolean
Left Generator Reset Button	L:var_GeneratorResetButton_R	Boolean

Left Starter-Generator Switch	L:var_StarterGenSwitch_L	0 = GEN, 2 = START
Right Starter-Generator Switch	L:var_StarterGenSwitch_R	0 = GEN, 2 = START
Left Fuel Pump Switch	L:var_FuelPumpSwitch_L	0 = WING, 2= AUX
Right Fuel Pump Switch	L:var_FuelPumpSwitch_R	0 = WING, 2= AUX
Left Oil Cooler Door	L:var_OilCoolerDoorSwitch_L	Boolean
Right Oil Cooler Door	L:var_OilCoolerDoorSwitch_R	Boolean
Left Ice Deflector	L:var_IceDeflectorSwitch_L	Boolean
Right Ice Deflector	L:var_IceDeflectorSwitch_R	Boolean
Fire Detector Test	L:var_FireDetectorTest	Boolean
Left Fire Extinguisher Push Button	L:var_extinguisherPushed_L	Boolean
Right Fire Extinguisher Push Button	L:var_extinguisherPushed_R	Boolean
Left Propeller Governor Test Button	L:var_propGovTestButton_L	Boolean
Right Propeller Governor Test Button	L:var_propGovTestButton_R	Boolean
Annunciator Brightness Dimming	L:var_AnnunciatorDim	Boolean
Carbon Monoxide Detector Test	L:var_CoTest	Boolean

Lighting Control Events & Variables

Description	**Variable**	**Range**
Pilot’s Yoke Map Light Button	L:OatMapCompassLightButton_1	Boolean
Copilot’s Yoke Map Light Button	L:OatMapCompassLightButton_2	Boolean
Nav & Strobe Lights	L:var_NavStrobeLights	0 = NAV, 2 = BOTH
Beacon & Recognition Lights	L:var_BeaconRecogLights	0 = BCN, 2 = BOTH
Wing/Ice Light	B:LIGHTING_WING_1_Toggle (K:TOGGLE_WING_LIGHTS)	
Taxi Light	B:LIGHTING_TAXI_1_Toggle (K:TOGGLE_TAXI_LIGHTS)	
Left Landing Light	B:LIGHTING_LANDING_1_Toggle (1 K:LANDING_LIGHTS_SET)	
Right Landing Light	B:LIGHTING_LANDING_2_Toggle (2 K:LANDING_LIGHTS_SET)	

Master Panel Lighting Switch	L:bksq_MasterPanelLights	Boolean
Left Panel Lights Dimmer	L:var_PanelLights_Left	0 - 100
Right Panel Lights Dimmer	L:var_PanelLights_Right	0 - 100
Engine Panel Lights Dimmer	L:var_PanelLights_Engine	0 - 100
Avionics Lighting Dimmer	L:var_PanelLights_Avionics	0 - 100
Red Flood Light Dimmer	L:var_PanelLights_RedFlood	0 - 100
White Flood Light Dimmer	L:var_PanelLights_WhiteFlood	0 - 100
Subpanel Lighting Dimmer	L:var_PanelLights_Subpanels	0 - 100
Pedestal Lighting Dimmer	L:var_PanelLights_Pedestal	0 - 100
Cockpit Dome Light	L:var_LIGHTING_Push_Cockpit_1	Boolean
Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_2	Boolean
Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_3	Boolean
Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_4	Boolean
Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_5	Boolean

Environmental Control Variables

Description	**Variable**	**Range**
Oxygen Flow Valve	L:var_oxygenOn	Boolean
Pilot Air Valve	L:XMLVAR_Cabin_Air_1_Position	0 - 100
Copilot Air Valve	L:XMLVAR_Cabin_Air_2_Position	0 - 100
Cabin Air Valve	L:XMLVAR_Cabin_Air_3_Position	0 - 100
Left Intercooler Bypass Valve	L:XMLVAR_Cabin_Heat_1_Position	0 - 100
Right Intercooler Bypass Valve	L:XMLVAR_Cabin_Heat_2_Position	0 - 100
Left Pressurization Air Shutoff Valve	L:XMLVAR_Cabin_Heat_3_Position	0 - 100
Right Pressurization Air Shutoff Valve	L:XMLVAR_Cabin_Heat_4_Position	0 - 100
Defroster Valve	L:XMLVAR_Cabin_Heat_5_Position	0 - 100
Environmental Mode Knob	L:var_EnvironmentalModeKnob	0 - 7
Vent Blower Speed Switch	L:var_ventBlowerHigh	Boolean

Cabin Temperature Select Knob	L:var_CabinTemperatureKnob	50 - 100
Pressurization Goal Knob	L:var_pressurizationGoal	-1000 - 15000
Pressurization Rate Knob	L:var_pressurizationClimbRate	150 - 2000
Pressurization Mode Switch	L:bksq_PressurizationMode	0 = TEST, 2 = DUMP

Instrument Variables

Description	**Variable**	**Range**
Autopilot Pitch Knob	L:var_AP_PitchKnob	-15 - 15
Altitude Alerter Button	L:var_altitudeAlertLatching	1 = ON, 2 = RESET
Altitude Selector Knob Push/Pull	L:var_AltitudeSelectorKnobPushed	Boolean
RNAV Drives HSI	L:var_rnavDrivesHsi	Boolean
Gyro Slaving Mode	L:var_GyroSlaveModeSwitch	Boolean
Dme Mode	L:var_dmeMode	0 - 4
Left True Airspeed Calculator	L:var_TrueAirspeedKnob_L	4.30 - 69.85
Right True Airspeed Calculator	L:var_TrueAirspeedKnob_R	4.30 - 69.85
RMI Solid Needle Mode	L:var_rmiSolidNeedleAdfMode_L	Boolean
RMI Hollow Needle Mode	L:var_rmiHollowNeedleAdfMode_L	Boolean
Copilot Gyro Compass Heading	L:var_copilotHeading	0 - 360
Pilot Transmitting Radio Selector	L:var_PilotTransmitSelector	0 - 1
Cabin Temperature Display Unit	L:var_CabinTempUnitMode	Boolean
ADF Card Heading	L:var_copilotAdfHeading	0 - 360

Primary Control Events Events

Description	Event
Battery Master	B:ELECTRICAL_Battery_1_Toggle
Avionics Master	B:ELECTRICAL_Avionics_Bus_1_Toggle
Left Pitot Heat	K:2:PITOT_HEAT_SET
Right Pitot Heat	K:2:PITOT_HEAT_SET
Alternate Static Air	K:TOGGLE_ALTERNATE_STATIC

Instrument Events

Description	Variable
Autopilot Master	K:AP_MASTER
Flight Director	K:TOGGLE_FLIGHT_DIRECTOR
Transponder Ident	K:XPNDR_IDENT_ON
Propeller Sync	K:TOGGLE_PROPELLER_SYNC
Autopilot Heading Mode	K:AP_PANEL_HEADING_HOLD
Autopilot NAV Mode	K:AP_NAV1_HOLD
Autopilot Approach Mode	K:AP_APR_HOLD
Autopilot Backcourse Mode	K:AP_BC_HOLD
Autopilot Altitude Hold Mode	K:AP_ALT_HOLD
Autopilot Pitch Hold Mode	K:AP_PITCH_LEVELER_ON
Autopilot Go-Around Mode	K:AUTO_THROTTLE_TO_GA
Altitude Selector Increase	K:AP_ALT_VAR_INC
Altitude Selector Decrease	K:AP_ALT_VAR_DEC
VLOC/GPS (when using GNS 530)	K:TOGGLE_GPS_DRIVES_NAV1 (H:AS530_CDI_Push)
Toggle COM1 Receive	K:COM1_RECEIVE_SELECT
Toggle COM2 Receive	K:COM2_RECEIVE_SELECT
Toggle COM3 Receive	K:COM3_RECEIVE_SELECT

Toggle NAV1 Receive	K:RADIO_VOR1_IDENT_TOGGLE
Toggle NAV2 Receive	K:RADIO_VOR2_IDENT_TOGGLE
Toggle ADF Receive	K:RADIO_ADF_IDENT_TOGGLE
Toggle DME Receive	K:RADIO_DME1_IDENT_TOGGLE
Toggle Marker Receive	K:MARKER_SOUND_TOGGLE
Toggle Marker High Sensitivity	K:MARKER_BEACON_SENSITIVITY_HIGH
Toggle RNAV Receive	K:RADIO_VOR3_IDENT_TOGGLE
Altimeter Baro Increase	K:KOHLSMAN_INC
Altimeter Baro Decrease	K:KOHLSMAN_DEC
Decision Height Increase	K:INCREASE_DECISION_HEIGHT
Decision Height Decrease	K:DECREASE_DECISION_HEIGHT
Emergency Gear Extension	K:GEAR_PUMP

Avionics Variables & Events

Not all variable and event names are listed here for multiple instances of avionics. For instance, to control a GTN 650, just replace “GTN750” with “GTN650”, or “H:AS530_1_MENU_Push” with “H:AS430_1_MENU_Push”. For communications radios, change the index to the corresponding radio, such as “K:COM1_VOLUME_INC” to “K:COM2_VOLUME_INC”. For Black Square aircraft with multiple GNS 530 units installed, increment the index, as well, such as “H:AS530_1_DRCT_Push” to “H:AS530_2_DRCT_Push”.

PMS50 GTN

Description	Variable or Event
Volume Knob Set	L:GTN750_Vol
Volume Knob Increase	H:GTN750_VolInc
Volume Knob Decrease	H:GTN750_VolDec
Home Button	H:GTN750_HomePush
Direct-To Button	H:GTN750_DirectToPush
Inner Knob Increase	H:GTN750_KnobSmallInc
Inner Knob Decrease	H:GTN750_KnobSmallDec
Knob Push	H:GTN750_KnobPush
Outer Knob Increase	H:GTN750_KnobLargeInc
Outer Knob Decrease	H:GTN750_KnobLargeDec

TDS GTNxi

Description	Variable or Event
Volume Knob Increase	L:TDSGTNXI750U1_LKnobInc
Volume Knob Decrease	L:TDSGTNXI750U1_LKnobDec
Home Button	L:TDSGTNXI750U1_HomeKey
Direct-To Button	L:TDSGTNXI750U1_DTOKey
Inner Knob Increase	L:TDSGTNXI750U1_RKnobInnerInc
Inner Knob Decrease	L:TDSGTNXI750U1_RKnobInnerDec

Knob Push	L:TDSGTNXI750U1_RKnobCRSR
Outer Knob Increase	L:TDSGTNXI750U1_RKnobOuterInc
Outer Knob Decrease	L:TDSGTNXI750U1_RKnobOuterDec

Working Title GNS 530

Description	**Variable or Event**
COM Volume Knob Increase	K:COM1_VOLUME_INC
COM Volume Knob Decrease	K:COM1_VOLUME_DEC
NAV Volume Knob Increase	K:NAV1_VOLUME_INC
NAV Volume Knob Decrease	K:NAV1_VOLUME_DEC
Radio Knob Push	H:AS530_1_LeftSmallKnob_Push
Radio Inner Knob Right	H:AS530_1_LeftSmallKnob_Right
Radio Inner Knob Left	H:AS530_1_LeftSmallKnob_Left
Radio Outer Knob Right	H:AS530_1_LeftLargeKnob_Right
Radio Outer Knob Left	H:AS530_1_LeftLargeKnob_Left
GPS Knob Push	H:AS530_1_RightSmallKnob_Push
GPS Inner Knob Right	H:AS530_1_RightSmallKnob_Right
GPS Inner Knob Left	H:AS530_1_RightSmallKnob_Left
GPS Outer Knob Right	H:AS530_1_RightLargeKnob_Right
GPS Outer Knob Left	H:AS530_1_RightLargeKnob_Left
Direct-To Button	H:AS530_1_DRCT_Push
Menu Button	H:AS530_1_MENU_Push
Clear Button Short	H:AS530_1_CLR_Push
Clear Button Long	H:AS530_1_CLR_Push_Long
Enter button	H:AS530_1_ENT_Push
COM Swap Button	H:AS530_1_COMSWAP_Push
NAV Swap Button	H:AS530_1_NAVSWAP_Push
NAV Ident Button	H:AS530_1_ID

CDI Button	H:AS530_1_CDI_Push
OBS Button	H:AS530_1_OBS_Push
Message Button	H:AS530_1_MSG_Push
Flightplan Button	H:AS530_1_FPL_Push
VNAV button	H:AS530_1_VNAV_Push
Procedure Button	H:AS530_1_PROC_Push

KLN90B

Description	**Variable or Event**
Brightness Knob Increase	H:KLN90B_Brt_Inc
Brightness Knob Decrease	H:KLN90B_Brt_Dec
Power Knob Push/Pull	H:KLN90B_Power_Toggle
Left Knob Outer Right	H:KLN90B_LeftLargeKnob_Right
Left Knob Outer Left	H:KLN90B_LeftLargeKnob_Left
Right Knob Outer Right	H:KLN90B_RightLargeKnob_Right
Right Knob Outer Left	H:KLN90B_RightLargeKnob_Left
Left Knob Inner Right	H:KLN90B_LeftSmallKnob_Right
Left Knob Inner Left	H:KLN90B_LeftSmallKnob_Left
Right Knob Inner Right	H:KLN90B_RightSmallKnob_Right
Right Knob Inner Left	H:KLN90B_RightSmallKnob_Left
Right Knob (Scan) Push/Pull	H:KLN90B_RightScan_Toggle
Left Cursor Button	H:KLN90B_LeftCursor_Toggle
Right Cursor Button	H:KLN90B_RightCursor_Toggle
Message Button	H:KLN90B_MSG_Push
Altitude Button	H:KLN90B_ALT_Push
Direct Button	H:KLN90B_DCT_Push
Clear Button	H:KLN90B_CLR_Push
Enter Button	H:KLN90B_ENT_Push

MD41 Approach Arm Button	H:KLN90B_ApprArm_Push
MD41 OBS Button	K:GPS_OBS
MD41 VLOC/GPS Button	K:TOGGLE_GPS_DRIVES_NAV1
MD41 Test Button	L:var_md41Test

KNS81

Description	Variable or Event
Data Knob Outer Increase	H:KNS81_bigInc
Data Knob Outer Decrease	H:KNS81_bigDec
Data Knob Inner Increase	H:KNS81_smallInc
Data Knob Inner Decrease	H:KNS81_smallDec
Mode Knob Increase	H:KNS81_modeInc
Mode Knob Decrease	H:KNS81_modeDec
Waypoint Knob Increase	H:KNS81_wptInc
Waypoint Knob Decrease	H:KNS81_wptDec
Use Button	H:KNS81_useButton
Return Button	H:KNS81_returnButton
Data Button	H:KNS81_dataButton
Data Entry Knob Push/Pull	L:var_rnavKnobPulled
Volume Knob	L:var_RNAV_VOLUME
Radial Button	L:var_RNAV_DMERADIALMODE

KX155B

Description	Variable or Event
COM Knob Outer Increase	H:RADIO1_COM_Knob_Large_INC
COM Knob Outer Decrease	H:RADIO1_COM_Knob_Large_DEC
COM Knob Inner Increase	H:RADIO1_COM_Knob_Small_INC
COM Knob Inner Decrease	H:RADIO1_COM_Knob_Small_DEC
COM Knob Push/Pull	H:RADIO1_COM_Knob_Small_PUSH
NAV Knob Outer Increase	H:RADIO1_NAV_Knob_Large_INC
NAV Knob Outer Decrease	H:RADIO1_NAV_Knob_Large_DEC
NAV Knob Inner Increase	H:RADIO1_NAV_Knob_Small_INC
NAV Knob Inner Decrease	H:RADIO1_NAV_Knob_Small_DEC
NAV Knob Push/Pull	H:RADIO1_NAV_Knob_Small_PUSH
COM Volume Increase	K:COM1_VOLUME_INC
COM Volume Decrease	K:COM1_VOLUME_DEC
COM Frequency Spacing Toggle	H:RADIO1_COM_Freq_Spacing_PUSH
NAV Volume Increase	K:NAV1_VOLUME_INC
NAV Volume Decrease	K:NAV1_VOLUME_DEC
NAV Ident Toggle	K:RADIO_VOR1_IDENT_TOGGLE
COM Swap Button	K:COM1_RADIO_SWAP
NAV Swap Button	K:NAV1_RADIO_SWAP

KR87 ADF

Description	Variable or Event
Tuning Knob Push/Pull	L:var_adfKnobPulled
Tuning Increase by 100	K:ADF_100_INC
Tuning Decrease by 100	K:ADF_100_DEC
Tuning Increase by 10	K:ADF_10_INC

Tuning Decrease by 10	K:ADF_10_DEC
Tuning Increase by 1	K:ADF_1_INC
Tuning Decrease by 1	K:ADF_1_DEC
Antenna Button	H:adf_AntAdf
BFO Button	H:adf_bfo
Frequency Swap Button	H:adf_frqTransfert
Timer Mode Button	H:adf_FltEt
Timer Reset Button	H:adf_SetRst

GTX 327 Transponder

Description	Variable or Event
Off Button	H:TRANSPONDER_Push_OFF
Standby Button	H:TRANSPONDER_Push_STBY
Test Button	H:TRANSPONDER_Push_TST
On Button	H:TRANSPONDER_Push_ON
Altitude Reporting Mode Button	H:TRANSPONDER_Push_ALT
0 Button	H:TRANSPONDER_Push_0
1 Button	H:TRANSPONDER_Push_1
2 Button	H:TRANSPONDER_Push_2
3 Button	H:TRANSPONDER_Push_3
4 Button	H:TRANSPONDER_Push_4
5 Button	H:TRANSPONDER_Push_5
6 Button	H:TRANSPONDER_Push_6
7 Button	H:TRANSPONDER_Push_7
8 Button	H:TRANSPONDER_Push_CLR
9 Button	H:TRANSPONDER_Push_VFR
Function Button	H:TRANSPONDER_Push_FUNC
Cursor Button	H:TRANSPONDER_Push_CRSR

Weather Radar

Description	Variable or Event	Range
Mode Knob	L:var_radarMode	0 - 5
Brightness Knob	L:var_RadarBrightness	0 - 100
Gain Knob	L:var_RadarGain	0 - 100
Tilt Knob	L:var_RadarTilt	0 - 100
Alert Button	H:bksq_wradar1_radarAlertToggle	
Vertical Profile Button	H:bksq_wradar1_radarProfile	
Map Button	H:bksq_wradar1_radarMap	
Hold Button	H:bksq_wradar1_radarHold	
Range Increase Button	H:bksq_wradar1_radarRangeInc	
Range Decrease Button	H:bksq_wradar1_radarRangeDec	
Track Left Button	H:bksq_wradar1_radarTrackLeft	
Track Right Button	H:bksq_wradar1_radarTrackRight	

ETM Engine Trend Monitor

Description	Variable or Event	Range
Mode Knob	L:var_EtmMode	0 - 3
Enter Button	H:Etm_EnterTest	
Record Button	H:Etm_Record	
Clock Reset Button	H:Etm_ClockReset	
Increase Switch	H:Etm_Inc	
Decrease Switch	H:Etm_Dec	
Page Up Switch	H:Etm_PageUp	
Page Down Switch	H:Etm_PageDown	
Cock Start Switch	H:Etm_ClockStart	
Cock Stop Switch	H:Etm_ClockStop	

Outputs

Since the Black Square Duke has many custom underlying simulations beyond that of the native simulator, the following variables should be used to access what would normally be a simulator-level value. If the quantity you are interested in does not appear in this list, it is safe to assume it should be accessed via the native simulator variable.

Aircraft & Engine Variables

Description	Variable	Units
Left Propeller Torque	L:BKSQ_DUKE_TQ_1	Number (FT-LBS)
Right Propeller Torque	L:BKSQ_DUKE_TQ_2	Number (FT-LBS)
Left Interstage Turbine Temperature	L:BKSQ_DUKE_ITT_1	Number (°C)
Right Interstage Turbine Temperature	L:BKSQ_DUKE_ITT_2	Number (°C)
Left Gas Generator RPM	L:BKSQ_DUKE_NG_1	Number (%)
Right Gas Generator RPM	L:BKSQ_DUKE_NG_2	Number (%)
Left Fuel Pressure	L:BKSQ_DUKE_FuelPressure_1	PSI
Right Fuel Pressure	L:BKSQ_DUKE_FuelPressure_2	PSI
Left Propeller RPM	L:BKSQ_DUKE_PROP_RPM_1	RPM
Right Propeller RPM	L:BKSQ_DUKE_PROP_RPM_2	RPM
Left Fuel Flow	L:BKSQ_DUKE_FuelFlow_1	GPH
Right Fuel Flow	L:BKSQ_DUKE_FuelFlow_2	GPH
Left Oil Pressure	A:ENG OIL PRESSURE:1	PSI
Right Oil Pressure	A:ENG OIL PRESSURE:2	PSI
Left Oil Temperature	L:BKSQ_DUKE_OILTEMPERATURE_1	FAHRENHEIT
Right Oil Temperature	L:BKSQ_DUKE_OILTEMPERATURE_2	FAHRENHEIT
Left Fuel Quantity	A:FUEL TANK LEFT MAIN QUANTITY	GALLONS
Right Fuel Quantity	A:FUEL TANK RIGHT MAIN QUANTITY	GALLONS
Left Vertical Speed Needle	L:BKSQ_DUKE_VerticalSpeed_1	FPM
Right Vertical Speed Needle	L:BKSQ_DUKE_VerticalSpeed_2	FPM
Turn Coordinator Ball	L:BKSQ_TurnCoordinatorBall	0 - 100

Battery 1 Temperature	L:var_batteryTemperature_L	FAHRENHEIT
Battery 2 Temperature	L:var_batteryTemperature_R	FAHRENHEIT
Oxygen Pressure	L:var_oxygenPressure	PSI
Cabin Climb Rate	L:var_cabinClimbRate	FPM
Cabin Pressurization Altitude	L:var_cabinPressurizationAltitude	FEET
Cabin Differential Pressure	L:var_cabinPressureDifferential	PSI

Radio Navigation Variables

While these variables may seem redundant, Black Square aircraft incorporate a signal degradation system, and physics based needles. Even the TO-FROM flags exhibit non-boolean behavior for a more realistic experience.

Description	**Variable**	**Range**
HSI CDI Needle	L:BKSQ_DUKE_HSI_LOC	0 - 100
HSI CDI Flag	L:BKSQ_DUKE_HSI_LOC_FLAG	Boolean
HSI TO Flag	L:BKSQ_DUKE_CDI_1_TO_FLAG	0 - 100
HSI FROM Flag	L:BKSQ_DUKE_CDI_1_FROM_FLAG	0 - 100
HSI Glideslope Needle	L:BKSQ_DUKE_HSI_GLIDE	0 - 100
HSI Glideslope Flag	L:BKSQ_DUKE_HSI_GS_FLAG	0 - 100
Localizer 2 CDI Needle	L:BKSQ_DUKE_LOC_2	0 - 100
Localizer 2 CDI Flag	L:BKSQ_DUKE_LOC_2_FLAG	Boolean
Localizer 2 TO Flag	L:BKSQ_DUKE_LOC_2_TO_FLAG	0 - 100
Localizer 2 FROM Flag	L:BKSQ_DUKE_LOC_2_FROM_FLAG	0 - 100
Localizer 2 Glideslope Needle	L:BKSQ_DUKE_GLIDE_2	0 - 100
Localizer 2 Glideslope Flag	L:BKSQ_DUKE_LOC_2_GS_FLAG	Boolean
Localizer 3 CDI Needle	L:BKSQ_DUKE_LOC_3	0 - 100
Localizer 3 CDI Flag	L:BKSQ_DUKE_LOC_3_FLAG	Boolean
Localizer 3 TO Flag	L:BKSQ_DUKE_LOC_3_TO_FLAG	0 - 100
Localizer 3 FROM Flag	L:BKSQ_DUKE_LOC_3_FROM_FLAG	0 - 100
Localizer 3 Glideslope Needle	L:BKSQ_DUKE_GLIDE_3	0 - 100

Localizer 3 Glideslope Flag	L:BKSQ_DUKE_LOC_3_GS_FLAG	Boolean
RMI Solid Needle	L:BKSQ_DUKE_RMI_1_SOLIDNEEDLE	0 - 100
RMI Hollow Needle	L:BKSQ_DUKE_RMI_2_HOLLOWNEEDLE	0 - 100
ADF Needle	L:BKSQ_ADF_BRG_1_Degraded	0 - 360
RNAV CDI Linear Deviation Mode	L:var_rnavCourseLinearFlag	Boolean
RNAV CDI Approach Deviation Mode	L:var_rnavApproachMode	Boolean
RNAV Waypoint Number	L:var_RNAV_WAYPOINT_NUMBER	1 - 10
RNAV CDI Needle	L:BKSQ_RNAV_CDI_Degraded	-127 - 127
RNAV CDI TO Flag	L:BKSQ_RNAV_TO_Degraded	0 - 1
RNAV CDI FROM Flag	L:BKSQ_RNAV_FROM_Degraded	0 - 1
RNAV Bearing Pointer	L:BKSQ_RNAV_BRG_Degraded	0 - 360
RNAV DME Distance Output	L:var_RNAV_DME	0.0 - 999.9
RNAV DME Speed Output	L:var_RNAV_DMESPEED	0.0 - 999.9
RNAV Frequency Data Display	A:NAV STANDBY FREQUENCY:3	Hz
RNAV Radial Data Display	L:var_RNAV_RADIAL_NUMBER	0 - 360
RNAV Distance Data Display	L:var_RNAV_DISTANCE_NUMBER	0.0 - 999.9

Annunciator Lights

The over 100 annunciators and indicator lamps in this aircraft are also accessible to home cockpit builders and 3rd party UI creators. There are too many to list here, but they can all be located in the TurbineDuke_INT.XML. Search for “BKSQ_DIMMABLE_ANNUNCIATOR” to find them all. Each one is accessible via an L:Var named according to the “NODE_ID” of the annunciator in the XML file, following the pattern (L:var_**#NODE_ID#**_readonly, bool).

For example, the master warning annunciator NODE ID is “MasterWarning_EM”, therefore…

The master warning annunciator L:Var is (L:var_**MasterWarning_EM**_readonly, bool).

Frequently Asked Questions

How do I open/close or move the tablet interface?

Click the back of the tablet **between the pilot's seat and the wall** of the cabin. Click the same area to close the tablet. The tablet can be moved by dragging its frame. If the tablet's bezel does not glow blue and cannot be dragged, switch to the modern control interaction method in the General Settings menu. For advanced users, the tablet position can also be set manually using L:var_efb_rot_x, L:var_efb_rot_y, and L:var_efb_dist.

How do I change which avionics/radios are installed?

The current avionics configuration is selected on the **options page of the tablet interface**. Once you've chosen your avionics, click the confirm button. Wait a few seconds for the change to take effect. For more information, see the "Tablet Interface" section of this manual.

How do I choose between the TDS and PMS GTN 750?

The current avionics configuration is selected on the **options page of the tablet interface**. The "PMS50 - TDS" toggle switch selects which GPS provider is used for the GTN 750/650. For more information, see the "Tablet Interface" section of this manual.

Why does the aircraft crash if I open the cockpit door?

Turn off "Aircraft Stress Damage" in the MSFS realism settings menu. This is the case for almost every addon aircraft with opening doors. The simulator interprets an open door as a catastrophic failure of the airframe.

Is beta range simulated?

Yes! This is a new addition to the Black Square turbine aircraft family. An accurate beta range is now fully simulated and **incorporated into the bottom 15% of forward throttle input travel**. Users who do not create virtual detents or have physical detents on their hardware peripherals will be using beta range anytime their throttle is below 15% See the "Beta Range" section of this manual for more information on beta range and the new turboprop engine simulation.

Do I have to use the tablet interface to set fuel & payload?

Absolutely not. If you prefer to use the native fuel/payload interface, you may always do so. Be aware that, due to a core simulator bug, the native payload interface may become desynchronized with the actual state of the aircraft. This has no effect on operation, and making any change will resynchronize the native interface.

Why is the autopilot behaving strangely, not changing modes, showing HDG/NAV simultaneously, or not capturing altitudes?

This is indicative of GPS addon incompatibility. Please make sure that you have updated all the avionics packages that you are using, including the TDS GTNxi 750, the PMS50 GTN 750, and the WT GNS 530, and that you do not have any outdated packages, such as the original PMS50 GNS 530 modification.

No additional packages should be required for the autopilot to work correctly with the various GPS choices. The product is tested with ONLY the TDS GTNxi 750, the freeware PMS50 GTN 750, and the free WT GNS 530 marketplace package installed. Please see the "Third Party Navigation & GPS Systems" section of this manual for more information.

Why do my engines always fail or lose health?

Managing a turboprop engine without FADEC or automatic torque limiters may be easier than managing a reciprocating engine in some ways, but damage can happen much more easily. The most likely culprit is exceeding engine torque or ITT limits. Be sure to watch the engine instrumentation and **engine data monitor for flashing exceedance warnings**. See the "Turboprop Engine Operation" section of this manual for more information.

Why does it take so much power to get the aircraft moving?

The aircraft will begin moving on level ground as soon as the power lever is out of the beta range (15% throttle input). As this implementation of beta range may differ from other turboprop aircraft that you are used to flying, it may appear as if significantly more power is required to get the aircraft moving, when **in reality, you're just advancing the power lever through the beta** range, where almost no thrust is produced. For more information on the realistic beta range implementation in this aircraft, see the "Beta Range" section of this manual.

How do I set the vertical speed of the aircraft?

This aircraft is equipped with a Century IV autopilot, which **controls the pitch of the aircraft directly, rather than the vertical speed** of the aircraft. The desired pitch of the aircraft is set with the motorized pitch knob on the Century IV autopilot controller. For more information, see the Century IV Autopilot section of this manual.

Why can't I enable the autopilot?

This aircraft has a toggle switch that controls power to the autopilot servo motors. Make sure the toggle switch to the right of the cockpit lighting dimmers, labeled **"PITCH TRIM" is in the on position.** Additionally, check the "PITCH TRIM" circuit breaker on the copilot's upper side panel to make sure power is available to the autopilot servo motors.

Why is the GTN 750 GPS or KLN-90B GPS screen black?

Make sure you have the PMS GTN 750 or TDS GTNxi 750 installed properly in your community folder. **The free addon can be obtained for free from the following link.**

https://pms50.com/msfs/downloads/gtn750-basic/

Make sure you have the Falcon71 KLN-90B installed properly in your community folder.
The free addon can be obtained for free from the following link.

https://github.com/falcon71/kln90b/releases

For more detailed Installation instructions see the “Installation, Updates & Support” section of this manual.

Why do some switches not work, or avionics logic seem broken?

This is almost always caused by default control binding of hardware peripherals, especially the Honeycomb yoke and throttle system. Due to how the electronics in these peripherals work, they often “spam” their control events, or set them, rather than toggle them. In either case, this can interfere with the operation of more complex aircraft, such as this one. Either create a control binding profile for this aircraft that does not attempt to send control inputs in the same manner as you would for default aircraft, but instead use the suggested method for this aircraft, or seek advice on using 3rd party hardware binding software, such as Axis and Ohs, SPAD.neXt, and FSUIPC.

Can the autopilot track KNS-81 RNAV waypoints?

Yes! This is a new feature in this aircraft. By the nature of how the KNS-81 autopilot has been implemented, it cannot conflict with other GPS sources of navigation; therefore, the KNS-81 can only drive the autopilot’s NAV mode in the no-GPS avionics configuration. For more information, see the “Using the KNS-81 RNAV Navigation System” or the “Bendix/King KNS-81 RNAV Navigation System” section of this manual.

Why is the state of my aircraft and radios not saved/recalled?

In order for the MSFS native state saving to work correctly, you must **shut down MSFS correctly** via the main menu, by clicking “Quit to Desktop”, NOT by pressing the red “X” on the application window, or otherwise terminating the application window.

Why does the engine not fail when limits are clearly exceeded?

The engine will not fail immediately upon limit exceedances, as is true of the real engine. Different engine parameters contribute differently to reducing the health of the engine. The **“Engine Stress Failure” option must also be enabled in the MSFS Assistance menu** for the engine to fail completely. Engine condition can be monitored via the engine pages of the tablet interface, or on the “SYSTEMS” page of the weather radar display.

Why do screens flicker at night when adjusting lighting intensity?

This is a long standing bug in MSFS with some graphics settings caused by the NanoVG renderer for legacy XML gauges. **Disabling NanoVG from the "Experimental" menu in General Settings** will stop the flickering. Black Square products do not use rendered XML gauges, so there will be no impact on performance.

Does this aircraft use Sim Update 15 ground handling improvements?

Sim Update 15 in February of 2024 introduced improved ground handling simulation, **greatly enhancing crosswind landings, taxiing, and aircraft vibration**. These optional parameters were incorporated into the entire Black Square fleet within 24 hours, because the improvement was so dramatic.

Why does the aircraft tip over or veer sideways during takeoff?

The ground handling physics added in SU15 make proper crosswind control deflection on takeoff essential. **With the ailerons deflected towards the wind, and nose-down pressure reduced during takeoff, the aircraft will not exhibit any of these behaviors**. While this might be more realistic than before SU15, the effect of nose wheel friction seems to be overdone, and will perhaps see improvements in future sim updates.

Why does the flight director not disengage when I press the autopilot disconnect button on my hardware yoke or joystick?

While the autopilot disconnect buttons in the virtual aircraft will always work as described in this manual, you must use a specific hardware binding for the autopilot disconnect button on your hardware to behave in the same way. **Use the event "AUTOPILOT_DISENGAGE_TOGGLE", rather than "AUTOPILOT_OFF".** This may cause the autopilots in other addon aircraft that have not implemented this feature correctly to not reengage. If this happens, just press your autopilot disconnect hardware button a second time to release the autopilot. For this reason, you can always use the "AUTOPILOT_OFF" event with Black Square aircraft, though you will have to disengage the flight director from the virtual cockpit.

Change Log

v1.0 - Initial Release (after public preview build)

New Features:

- TBD

Bug Fixes:

- TBD

Credits

Turbine Duke	Nicholas Cyganski
Publishing	Just Flight
Audio	Boris Audio Works
Liveries	Ryan “ryanbatc” Butterworth
	Tim "TimHH" Scharnhop
Manual	Nicholas Cyganski
Testing	Just Flight Testing Team

Dedication

This dedication previously appeared at the end of Black Square’s TBM 850 manual. That product has since been rededicated to a very special member of the aviation community.

My first software release for Microsoft Flight Simulator was dedicated to the father of digital flight simulation, Bruce Artwick, creator of the Flight Simulator franchise. This product is dedicated to the father of physical flight simulation, Edwin Albert Link, who passed away mere months before Microsoft would release Flight Simulator 1.0. Link created the first pilot training simulator, known as the “Link Trainer” while in his mid-20’s. The trainer received modest orders during the Interwar period, but over 10,000 were produced during WWII. While the physical simulator may seem primitive by today’s standards, the pneumatically controlled fuselage and instructor station could simulate instrument flight conditions and failures, including: wind, turbulence, fuel starvation, spins, radionavigation, control forces, and could even draw the flight’s path on maps of different scale for debriefing. Many Link Trainers have been preserved, with a few in “flight” worthy condition, and they can be found on display all over the world. This software is dedicated to Ed Link, and all the innovators in flight simulation who found ways to educate student pilots long before the bits and bytes of the computer age.

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