QualityWings SIMULATIONS

Complexity...*Simplified!*

The Ultimate 146 Collection
User's Manual

Disclaimer
This manual is not provided from, or endorsed by BAE Systems or any airline in any manner. This manual is not intended for real world flight. It is only for use in Microsoft Flight Simulator.

Copyright
ALL elements of the QualityWings Simulations "Ultimate 146 Collection" are full copyright protected work. Reproduction and/or redistribution is STRICTLY PROHIBITED. Any exceptions are listed below.

Exceptions

Repaint Policy
(This copyright policy is subject to change without notice)

Repainting is allowed using the provided repaint kit but subject to the following conditions:
- Modified textures may only be redistributed as freeware!!
- Modified textures may only be used on the QualityWings Ultimate 146 Collection
- Repaints maybe distributed to 3rd party site such as Flightsim.com or Avsim.com, however they must conform to the QualityWings format as prescribed in the User's Manual!
- If the repaint is published at the third party web site, 'QualityWings' must be listed in the author credits.
- End users may contact a repaint artist directly with questions and/or comments.
- No textures whether from the repaint kit or not may be used in any other project regardless if it is commercial or freeware!
- Modification and/or distribution of any part of the product except the repainted/modified texture files is STRICTLY PROHIBITED!
- All repaints (free liveries) created using the QualityWings BAe146 / Avro RJ Repaint Kit remain the property of QualityWings Simulations.

Content

INTRODUCTION

INTRODUCTION

Thanks for purchasing The Ultimate 146 Collection from QualityWings Simulations. After a development time of more than three years, we at QualityWings hope you enjoy this add-on as much as we've enjoyed developing it for you.

This addon product package represents the BAe146 and Avro RJ series, a four-engine regional aircraft series by British airplane manufacturer British Aerospace. All produced passenger variants have been included, such as the old BAe146-100, -200 and the newer BAe146-300, but also the heavily upgraded Avro RJ series, comprising of the RJ70, RJ85 and RJ100. All models have been skillfully built by our dedicated team, both on the inside and outside, using real aircraft plans and the expert opinion of active BAe146 / Avro RJ pilots.

In the systems department we strive for an accurate representation of the real plane. The most important systems are fully functional, whereas many other systems are partly functional and simplified in some areas. This was a conscious decision and it enables many newcomers to our hobby to fly this magnificent plane without having to worry too much about all the more advanced systems. To please the more seasoned simmers, the partly functional systems still function so much that their operation can affect flight performance.

For your pleasure, every model comes with its own 2D Panel and Virtual Cockpit to fully capture the spirit and identity of these jets. What else carries the spirit of an airplane? The sounds of course! An airplane simulation has never sounded more realistic than this package and we are quite sure you will be pleased with the immersion we created.

The most important facts about this package:

- All Passenger BAe146 and Avro RJ models (six in total)
- Three different 2D Cockpits and 3D Virtual Cockpits
- Two different Flight Management Systems (GNLU910 and GNS-XLS)
- Advanced Mid-Level Systems with an optional LITE-Mode
- Autopilot with Autoland capability (depending on model)
- Incredibly realistic sound package featuring the Avco Lycoming ALF507-1F, EICAS Aural Warnings, GPWS and Flightdeck Environment Sounds
- Realistic Flight Dynamics for each variant, tested by real world Avro RJ Pilots

PRODUCT PACKAGE OVERVIEW

PRODUCT PACKAGE OVERVIEW

EXTERIOR MODELS
Choose between six highly accurate and detailed models.

- British Aerospace BAe146-100
- British Aerospace BAe146-200
- British Aerospace BAe146-300

- British Aerospace Avro RJ70
- British Aerospace Avro RJ85
- British Aerospace Avro RJ100

There are over 100 Custom animations on the exterior models including, but not limited to:
- *Shock Strut Compression*
- *All Flight Controls*
- *Detailed Tailcone Speedbrake & Liftdumpers*
- *Landing gear w/Nose wheel steering*
- *Left Side Passenger Doors with correct animation*
- *Air Stair*
- *Cargo doors*
- *Realistic Wing Flex*
- *Moving pilots*
- *Opening Flightdeck Windows*
- *Remove before Flight Tags*

And Much, much more….

LIVERIES
Choose from over 60 High quality real-world liveries for free from the QualityWings painters.

REPAINT KIT
We've provided a detailed paintkit for those who would like to paint their own liveries. There are many effects included to ensure that ANYONE can make great looking paints! It also includes MANY option layer sets allowing you to match several different airline configurations.

FLIGHTDYNAMICS
Each variant comes with its own flight dynamic to make you not only see, but actually feel differences in thrust, weight and engine characteristics.

SOUNDS

A realistic ALF507 soundset including various cockpit environment, EGPWS and miscellaneous sounds.
The FSX version makes use of advanced sound cone design to give an even more realistic immersion.

 • Authentic Soundset for the Allied Signal LF-507 engine
 • Optimized to eliminate phasing sounds
 • Flightdeck Environment Sounds (Equipment Cooling, FSB/NS Signs, etc.)
 • Aural Warnings (Chimes, Horns, etc.)
 • Ground Proximity Warning System (GPWS)
 • Realistic Click-sounds in the Cockpit

COCKPITS

Depending on the selected model, we offer three different Cockpit layouts.
Each represents a different evolution of the airplane and is available as 2D and 3D virtual cockpit.
Cockpit layouts are:

-BAe146-100 and -200 style cockpit (fully analogue) featuring GNS-XLS FMS
-BAe146-300 style cockpit (simple EFIS) featuring GNS-XLS FMS
-Avro RJ series style cockpit (full EFIS) featuring GNLU910 FMS

• Detailed 2D Cockpit featuring both Widescreen (16:10 aspect ratio) and Standard (4:3 aspect ratio)
  resolution bitmaps
• Detailed 3D Virtual Cockpit with parallel functionality as 2D environment. If it works in the 2D, it
  works in the 3D
• Autopilot with VNAV, LNAV, Flight Level Change and Autoland capability
• Thrust Rating Panel
• Full simulation of Electric, Fuel, Hydraulic and Pneumatic systems
• Transponder with FSINN / Squawkbox compatibility
• Traffic Collision Avoidance System with aural warning sounds
• Customizable Ground Proximity Warning System (GPWS) with FULL Altitude Callout. You choose
  which callouts you want!
• Standard and LITE panel modes available on the fly via the QualityWings Control Panel. Standard
  mode balances realism and simplified approach. Optional LITE mode available for those who REALLY
  want things SIMPLE.
• Options Galore (Available via Config file)
• Two different Flight Management Systems depending on variant selected (GNLU910 or GNS-XLS)
• Over 200 Annunciators
• Master Warning and Central Status Panel
• Selectable Landing Flap Datum
• Steep Approach mode (inhibits GPWS warnings)
• Speedcard giving you the correct reference speeds

HISTORIC BACKGROUND

HISTORIC BACKGROUND

The BAe146 has a long history. Like other aircraft of British Aerospace Systems, the original design was not made by BAe themselves. Rather, it traces its origins far back. Much like the BAe Jetstream series of planes, which started out with Handley-Page, the BAe146 can be traced back to an old and well-known British aviation company: De Havilland.

De Havilland was a pioneer in its time and has designed and built various models that are still well known, sometimes even legendary, aircraft. The World War 2 combat plane "Mosquito" will probably ring a bell with many people, for instance. Also the De Havilland Comet (DH 106) is a legendary plane, for it was the very first commercial jetliner. Also we mustn't forget the DH 121 Trident, more commonly known as the Hawker Siddeley Trident. De Havilland subsidiary De Havilland Canada (DHC) is also responsible for aircraft such as the DHC 6 Twin Otter, DHC 7 and the DHC 8 (commonly known as the Dash 8), now produced by Bombardier.

In the 1960s, it was De Havilland that started a project that would end up as the BAe146 series of aircraft. The design by De Havilland was for a small twin turboprop, high wing feederliner designated "DH.123". Hawker Siddeley had bought De Havilland in 1960 however, but had kept it as a separate company up until 1963. De Havilland has been doomed as an independent company due to several high profile crashes with several of their later aircraft, of which many were jetliners. The Comet is the most infamous example, suffering three crashes in two years, thereby rocking the trust one had in commercial jetliners. Also the explosion of the DH 110 in 1952 at the Farnborough Airshow attracted little positive news. Finally, although De Havilland had returned to the airline scene with the De Havilland Trident, many airlines found it unattractive due to the fact that it was almost tailor built for one airline and, specifically, its owner: Lord Sholto Douglas, then owner of British European Airways. Thus De Havilland ended up at Hawker Siddeley: due to a series of failures that resulted in great economic troubles.

With the demise of De Havilland, the plans for the twin turboprop did not get erased from history however. Hawker Siddeley deemed them interesting and thus a reboot of the project ended up in new plans, this time for a low wing jetliner with two engines mounted on the rear fuselage of the plane, a design also seen on many modern regional jetliners, such as the Fokker 100 and Embraer ERJ 145. This new design was known as "HS.144". Sadly, the design went nowhere due to the unavailability of a power plant sufficient to get the plane safely into the air and down again.

In 1971 a revision of the HS.144 saw a brighter future: The HS.146. The HS.144 had been revised into a design in which we can see the BAe146-100 for the first time. The HS.146's, wings were mounted high instead of low, and the rear engines were once again mounted under the wing, much like the HS.143 had been designed. The notable difference being, of course, the swapping of turboprop engines for four turbofan engines. This was a design that Hawker Siddeley was willing to carry on with and backed with the government's support, a formal development would be started on the 29th of August 1973.

The seventies were not favorable for companies, and also not for Hawker Siddeley. The great oil crisis left its mark on economy. The UK with left in economic recession, with an oil embargo, energy crisis and on top of that there was a Mideast war going on. Understandably, the government backed out of the support it had given Hawker Siddeley. With the government gone and Hawker Siddeley having its own problems due to the oil crisis, the HS.146 was abandoned - for now. The HS.146 would return, but not as a Hawker Siddeley aircraft.

In 1977, hawker Siddeley was no more. That is, it existed, but under a new name. Due to the Aircraft and Shipbuilding Industries Act, Hawker Siddeley was merged with British Aircraft Corporation (BAC) and Scottish Aviation to form British Aerospace (note that Hawker Siddeley was a concern: its aviation branch was only one part and the rest of Hawker Siddeley was retained as "Hawker Siddeley group" after 1980). This act's goal was to nationalize all Aircraft and Shipbuilding companies, and thus make two big companies: British Aerospace and British Shipbuilders. Understandably, this evoked a lot of opposition, but after three years of debating it came through and thus two new companies were born.

How British Aerospace came into being accounts for why some of the BAe aircraft have such a long history. BAe is, in fact, a bunch of companies stuck together to form one, and as a result, the designs and projects proposed in the original companies, were hauled into BAe when it was first formed. This happened with the Jetstream, for example, but also with the BAe 146. This also explains the number "146". The DH.123 was simply the designation for a new type of plane in a line of many (it simply followed up on the DH.122, DH.121 etcetera). When that design was revised into the HS.143, Hawker Siddeley had adapted the number into its own line of products, and that 143 turned into 144 for the next aircraft design should be no surprise. BAe simply took the final Hawker Siddeley designation (HS.146) and used the number in the aircraft's new name: BAe146.

BAe rebooted the HS.146 project in 1978, only a year after it was formed. They received government support once again and started building the first prototype planes. In the beginning, they focused on the 100 and 200 variants, with the 300 coming later.

Variants

BAe146-100

The very first BAe146-100 flew on the 3rd of September 1981, three years after BAe rebooted the project. Certified on the 20th of May 1983, Dan Air was the launch customer, operating the BAe146-100 on it's very first revenue flight on the 27th of May 1983.

The BAe146-100 is the smallest member of a small regional jetliner family, offering quiet, efficient operations with a distance of up to 1500 Nautical miles (which is 2750 Km). Its wings are high mounted with four ALF502R-3 engines mounted under those. It has a T-tail and tricycle landing gear, with dual wheels on all gear assemblies. Due to its triple-slotted flaps it can take off over short distances and thanks to heavy-duty breaks, landing rollout distance is reduced somewhat, helping it operate into and out of small airport. It has a passenger capacity of 70 to 80, depending on the airline's choices in interior decorating. Various seat arrangements offer the airline a wide range of possibilities, too. A 6 abreast economy, 5 abreast economy class or 4 abreast first class are options, but these can also be mixed to thus give rise to a "mixed class" cabin layout.

ECONOMY CLASS	BUSINESS CLASS	FIRST CLASS
6-abreast 17'' seats	5-abreast 19'' seats	4-abreast 53'' double seats
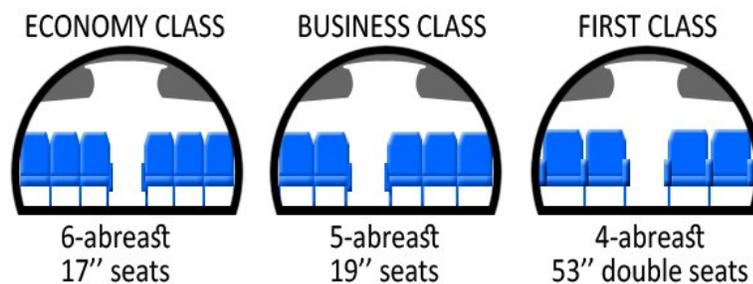
Moving to the front of the plane, we end up in the flight deck. With hardly any digital instrumentation, we look at an almost sixties era cockpit, with all analog gauges. If anything, the cockpit really resembles a Boeing 737-200's cockpit. We find many gauges that are of roughly the same type, look and feel. The only thing that really stands out and seems to be a typical British Aerospace thing is the board of warning lights. This is a big, black, block of lights that alter the crew to whatever bad or unusual happens on the plane. Why is this a typical British Aerospace thing? For the reason that other planes they manufactured have the same thing. The Jetstream 4100 is one of them. In fact, it is this black block that reminds us that we are not still in the sixties. By all means, the BAe has a rather outdated cockpit, as the picture on the next page should make clear.

BAe146-100 and -200 Main Panel

The BAe146 was an aircraft seemingly not as advanced as its competitors. In the age of aircraft like the F/A-18 Hornet, Boeing 767 and Airbus A310, one could say the BAe146 was lagging behind. The Boeing 767 flight deck, for example, features EFIS (Electronic Flight Instrument System), which the BAe146 does not have. Most interesting is also that not all BAe146 aircraft seemed to have a full FMS. Some of them have been fitted with a Honeywell GNS-XLS, which is what we have chosen to simulate in our product.

Those that were not fitted with a GNS-XLS FMS had the Trimble FMS. This was a very, *very* basic FMS. Unlike the GNS-XLS, it did not have a pictorial screen, had no link with the autopilot for LNAV (more on that later) and was not B-RNAV approved. B-RNAV stands for *Basic Area Navigation*. For a FMS to be approved for B-RNAV, the FMS has to have a minimal accuracy of +/- 5 NM, 95% of the time through-out the entire flight. The Trimble FMS not being approved for this requirement shows how very basic it was.

The GNS-XLS is a simplified FMS, but it gives you all the tools necessary to conduct your flight with a relative amount of automation. It gives you, for example, LNAV, which stands for Lateral NAVigation. This is a mode by which the autopilot automatically follows a flightplan that has been entered into the FMS.
What it does not give the pilot is VNAV. VNAV stands for Vertical NAVigation and is an autopilot mode that takes care of climb and descent. The difference with having VNAV or not, is the amount of auto-mation. The BAe 146's autopilot did always feature a mode to climb and descend, but in those cases, the pilot would still have to manually set up the climb and descent. It does feature calculations to set up the climb or descent manually though. So while it gives the tools to descend and climb, it is the pilot that has to *initiate* this descent or climb.

As said, the BAe146 does not have autothrottle. This is not completely true, however. The BAe146-100 does feature a TMS (Thrust Management System), which in a strict sense *is* an autothrottle. However, a true autothrottle system will try and set the required amount of engine thrust whatever the engine's current N1. The BAE 146-100's TMS will only set the correct amount of thrust when the throttle levers are within at least 2% of the required N1. This requires the pilot himself to set the throttle levers at the right spot, before the TMS will fine-tune the amount of engine thrust.

The thrust levers are connected to the engines via a hydro mechanical unit, which means that the connection between engines and throttle levers is very direct. If you are not careful, you can rather easily overspeed and destroy the engines. Great care must therefore be taken to not to drive N1 up too much especially on takeoff. When temperatures are higher, even more care must be taken, as engine performance is heavily degraded when outside air temperatures rise.

The engines on the BAe146 are four USA Avco Lycoming ALF502R-3 engines, with 6700lb thrust each. The four engines are all twin spool, high bypass twin turbofan engines. This specific engine type was fitted only on very early BAe146-100 and 200 aircraft. Soon a modified version appeared: the ALF502R-3A, with 6970lb thrust. With the introduction of the BAe146-300 the third evolution, the ALF502R-5 was built. This engine model was first exclusive to the BAe146-300, but ended up being fitted on all newly built BAe146 models.

The ALF502R-5 is known for being very quiet, making it the ideal fit for operation into and out of dense urban areas, which is the type of environment the BAe146 would be operated in. Airports such as London City, Innsbruck and Stockholm Bromma in Sweden are all sensitive to noise due to their location close by urban areas. It is these airports the BAe146's ALF502R-5 is ideal for.

BAe146-200

The BAe146-200 is essentially the same plane as the BAe146-100, only differing in length of the fuse-lage. The 200 was by no means meant as an upgrade of the original model in the way the Boeing 737-200 was an upgrade of the 100, for instance. Instead, the 100 and 200 were designed and built at the same time, the 200 being an extended version of the 100, capable of carrying a max of 112 passengers.

On the flight deck the two models are the same. Since they were designed and manufactured around the same time, they were fitted with the same instruments and have the same cockpit layout. Also the Trimble and GNS-XLS FMS systems are to be found on the -200, but like with the -100, the GNS-XLS is fitted on far more 200 models than the Trimble FMS. As with the -100, we have chosen to simulate the GNS-XLS.

Structurally, the two planes are also the same, the only difference being the longer fuselage of the -200. However, it did see some extra variations that were never made for the -100.

- A QT, or *Quiet Trader* model with designed specifically for hauling cargo. The addition of a large, rear cargo door and removal of all chairs, the aircraft became a good cargo jetliner for the short haul. Again, due to it being a very quiet airplane, it could operate into and out of airports in urban areas with ease. 14 of these were made.

- A QC, or *Quick Change* model offers great versatility by allowing a "quick change" from cargo mod-el to passenger airliner in between flights, even being able to offer a mix between the two. *Pal-letized seats* offer the possibility of adding in and taking out seats where otherwise cargo contain-ers would have stood. The large cargo door was also present on the QC, but it was dressed with all the usual passenger aircraft cabin.

In total 35 of the 100 series were produced and 116 of the 200 series. Many of the purchasers were European based companies, but also companies over the rest of the world were to adopt these mod-els. It is the 300 series, however, that is still flying today for many companies.

BAe146-300

The BAe146-200 saw a further extension of its fuselage by 4.93 meters, allowing a max passenger capacity of 128 passengers. This new variant, designated BAe146-300, would not only change in the length of the fuselage, but also in the appearance of its flight deck. EFIS style instrumentation was installed, making a move to a digital cockpit. As the figure below shows, the analog ADI and HSI have been replaced by an EADI and EHSI (the E stands for *Electronic*), and the analog engine instruments have been replaced by their digital counterparts. For the rest, only little has changed.

BAe146-300 Main Panel

The BAe146-300 is a true modernization of the older types, but it's still a lot more basic than many might think. Usually, when we think of a plane featuring EFIS, an image of an EADI with speed, altitude and vertical speed indications such come into mind, but the BAe146-300 has none of the latter. It has the EADI, but that's it: for speed and altitude indications the pilots still rely on analog instruments. The first BAe146-300 was delivered in 1988: a year in which much more advanced EFIS systems had already been available. The Boeing 767, first flight in 1981, had much more sophisticated EFIS.

What's the difference? Why does the BAe146-300 not have it? It is because of the purpose of the various plane models. The BAe146 series is a regional jetliner, and thus typically does not need the "extra" investment to fit it with fancy EFIS when the pilots can make do perfectly with less advanced systems.

The Boeing 767, on the other hand, is used for medium and long haul flights. Its "sister", the Boeing 757 (which was also done by QualityWings ;-)), is used for intercontinental flights. Pilots sit for hours on end in the flight deck; not having autothrottle would mean that on a normal intercontinental flight between New York and Amsterdam, the pilot would have to continually check and adjust the thrust. You can imagine that's not a desirable prospect. The BAe146 series, however, are operated on flights often less than two hours. Because of this, stuff such as advanced autothrottle, while helpful, is not necessary. In these cases airlines prefer to spend less than to have the latest in technology.

The figure above clearly shows how the EADI looks. The absence of the speed and altitude tapes and vertical speed indication, are apparent. On the other hand, activated auto pilot modes are shown, as are ILS indicated indications. The EHSI, or ND (for *Navigation Display*), is a lot more conventional than the EADI is, though. Like modern day NDs it shows your route, airports, waypoints, wind speed and direction, and it can also overlap the weather radar so you can instantly see on what parts of the route you could encounter bad weather.

Of the 300 series a QT (Quiet Trader) variant was made which sported much the same features as the 200QT discussed earlier. Of the 300QT, 10 aircraft were built of a total of 71 300 series aircraft. By the end of production of the BAe146 series, a total of 222 machines were built (including prototypes). Many of these are still in service around the world. The last BAe146 series aircraft were delivered in 1993.

A new Era: The Avro Series

In 1990, three years before the last BAe146 aircraft were delivered, British Aerospace had kicked of a whole new project: The Avro RJ series. The Avro RJ aircraft are a "reboot" of the BAe146, sporting many huge improvements to both the cabin and the flight deck, but the exterior model has been left untouched somewhat. These are some of the most important improvements:

- Better reliability
- Lycoming ALF507 engines instead of the previously used ALF502 series.
  This engine is the successor to the ALF502 series
- FADEC (*Full Authority Engine Control*): FADEC is a system that controls engine performance automatically, adjusting N1 and N2 values as needed, depending on systems engaged, air temperature, etcetera. This includes safety protections which no longer allow driving the engine out of its operational range (e.g. overspeed). If anything, FADEC might be regarded as one of the biggest advances the Avro RJ featured.
- Automatic pressurization systems
- An improved flight deck, featuring better EFIS instrumentation and a new FMS systems, although much of the layout of the flight deck, including the instrumentation is pretty much the same as we previously found on the BAe 146-300. The EFIS instrumentation now has an EADI with a speed tape and vertical speed indication. Also note the addition of a *Central Status Panel*, or CSP, right below the *Master Warning Panel* (which is the big black block of Annunciators you see just right of the *Engine Instrumentation System*).
- The New FMS is a GNLU 910. The addition of this new FMS is a giant leap forward from the older GNS-XLS found on the 146 series, which, as you might remember, gives LNAV but no true VNAV. The GNLU 910 does give VNAV, which actually is a rarity among regional airliners.

This is only a selection of what has been improved on the Avro RJ series, relative to its forefather, the BAe 146 series. There are more improvements, mostly minor, both structural and of the systems. Next we'll look at each of the new Avro RJ family members.

Avro RJ Main Panel

Avro RJ70

The Avro RJ70 is a modernization of the BAe146-100. Looking over the dimensions and comparing them to the BAe146-100, you might have noticed some interesting points. For example, the dimensions are exactly the same, evidence of the fact that the airframe has not been revised fundamentally in any form or part. However, you will have noticed the differences in range, weight and altitude.

Look closely. What's interesting is how in many respects, it seems the BAe146-100 is actually *better* than the Avro RJ70. You might be wondering how this can be, because you'd expect a newer model to outperforms its older sibling. It is important to realize that the Avro RJ70 has a max cruise altitude of 35000 feet, which is 6000 feet higher than the BAe146-100. Moreover, the RJ70 can fly it with the same weights the BAe146-100 also operates with.

This does come at a cost. If you look at the maximum range of the Avro RJ70, you'll notice its 500 kilometers less than the range of the BAe146-100. However, this is only with normal fuel. If you max out the payload of the BAe146-100 (max passengers/cargo and max fuel), the Avro RJ70 clearly shows the worth of the new engines and efficiency improvements. Here it is where the Avro RJ70 clearly gains (because it can still fly as far as it otherwise would be able to), while the BAE 146-100's range is dramatically decreased.

Overall, the RJ70 is a significant improvement over its predecessor. The modernized flight deck, efficient engines and new cabin, together with new specifics, make an aircraft that is ideal for short, low capacity flights.

A relatively small number of 11 RJ70 are still in use. Turkish Airlines is one of few operators of this type.

Avro RJ85

Following the RJ70, the Avro RJ85 is a modernization of pretty much the same way of the BAe146-200 as the RJ70 is of the BAe146-100. It has pretty much the same specifications, but due to a size increase, the range is smaller than of the RJ70, which shouldn't be surprising: a bigger size accounts for more weight, and thus more fuel needed to keep the plane in the air over a distance that would have cost the RJ70 less fuel. However, with a longer fuselage comes more capacity, too. The RJ85 is therefore a suitable candidate for those short haul, medium capacity flights, such as feeder flights: auxiliary flights that carry passenger from smaller destinations to large terminals. Hamburg-Frankfurt could be such a flight, for example.

The RJ 85 is currently the most used model of the series, with 86 currently in use all over the world.

Avro RJ100

Just like the RJ85 being a modernization of the BAe146-200, the RJ100 is a modernization of the BAe146-300. It has the same specifications, mostly, but, like with the RJ70 and RJ85, it scores much better on cruise altitude and range at maximum payload. This is also where there is a small surprise: whereas the RJ70 and RJ85 have the same range with normal fuel and max payload, the RJ 100 actually has a greater range. This is possibly due to the extra fuel that can be taken on board versus the amount of cargo and passengers that can be taken extra on board. If this fuselage stretch enables the taking of more fuel than is needed to take extra passengers, the range will increase slightly.

The RJ100 is the biggest of the Avro RJ series, and it enables short haul, high capacity flights between large airports. Munich-Frankfurt comes into mind. Still, the RJ100 is less used than the RJ85. 68 RJ100 aircraft fly to this day, with 71 initially produced. This is a trend one often sees in the aircraft industry and it is therefore not surprising to see it here too. For example, the Boeing 757-200 is much more often used than the Boeing 757-300, because, as was already explained, a longer fuselage requires more fuel, and due to extra weight, the range often decreases. It is because of this that carriers often opt for the model that makes the best compromise: more passengers versus increased range. The "middle" model is almost always the answer to the carrier's problem: while it carries fewer passengers, it has a longer range and possibly lower fuel costs.

End of the line

With the coming of the Avro RJ, a classic series of aircraft had been updated. British Aerospace didn't want this to be the end of line, however, and they set out to produce an even newer series of aircraft: the Avro RJX. These were to be lengthened, long range variants of the Avro RJ series. The program was launched in 2000, with a RJX85 model flying for the first time on the 28th of April 2001. An RJX100 followed on the 23rd of September. However, with the Al Qaida attack on the World Trade Center roughly two weeks before the RJX100's first flight, British Aerospace started getting into trouble. With the public getting nervous about flying, pressure rising on airlines and the start of an economic downturn, British Aerospace decided to terminate the RJX program. The program was formally ended on the 27th of November 2001.

The termination of the RJX program signified the end of the production of an aircraft whose history can be traced back into the 1960s. After a take-over and a merger it was finally British Aerospace that would rise up to the challenge of producing what would be the BAe146 series. They saw it succeed and produced a modernized version that is still flying around Europe in great numbers. Thus is the story of a British regional jetliner.

Avro RJX100 Prototype at Manchester Ringway airport

GENERAL DATA

General Data

The following tables show the most important design facts of the included airplanes.

Variant	BAe146-100		BAe146-200		BAe146-300	
Unit	Metric	English	Metric	English	Metric	English
Length	26.2 m	86 ft	28.59 m	93.8 ft	30.99 m	101.8 ft
Height	8.61 m	28.3 ft	8.59 m	28.2 ft	8.59 m	28.2 ft
Wingspan	26.2 m	86 ft	26.2 m	86 ft	26.2 m	86 ft
Wing Area	77.3 m²	832 ft²	77.3 m²	832 ft²	77.3 m²	832 ft²
Empty Weight	23290 kg	51340 lbs	23890 kg	52650 lbs	24880 kg	54850 lbs
MTO Weight	38136 kg	84000 lbs	42184 kg	93000 lbs	44225 kg	97500 lbs
Cruise Speed	765 km/h	415 kts	765 km/h	415 kts	765 km/h	415 kts
Cruise Altitude	8840 m	29000 ft	8840 m	29000 ft	8840 m	29000 ft
Range	3000 km	1620 Nm	2910 km	1570 Nm	2817 km	1040 Nm

Variant	RJ70		RJ85		RJ100	
Unit	Metric	English	Metric	English	Metric	English
Length	26.2 m	86 ft	28.59 m	93.8 ft	30.99 m	101.8 ft
Height	8.61 m	28.3 ft	8.59 m	28.2 ft	8.59 m	28.2 ft
Wingspan	26.2 m	86 ft	26.2 m	86 ft	26.2 m	86 ft
Wing Area	77.3 m²	832 ft²	77.3 m²	832 ft²	77.3 m²	832 ft²
Empty Weight	23290 kg	51340 lbs	24600 kg	54234 lbs	25600 kg	56438 lbs
MTO Weight	43091 kg	95000 lbs	45132 kg	99500 lbs	46039 kg	101500 lbs
Cruise Speed	555 km/h	300 kts	555 km/h	300 kts	565 km/h	305 kts
Cruise Altitude	10668 m	35000 ft	10668 m	35000 ft	10668 m	35000 ft
Range	3075 km	1660 Nm	2965 km	1600 Nm	2760 km	1490 Nm

AIRCRAFT DIMENSIONS

Side Views

KEY FACTS
- high wing configuration for better engine ground clearance
- T-tail configuration
- circular fuselage cross section
- two passenger doors on the left, two service doors on the right side
- two cargo doors on the right side
- 3.42m (11.3 ft) internal cabin diameter, allowing seating up to six abreast

RJ100 & BAe146-300

RJ85 & BAe146-200

RJ70 & BAe146-100

26.20m (86.0 ft)

28.59m (93.8 ft)

30.99m (101.8 ft)
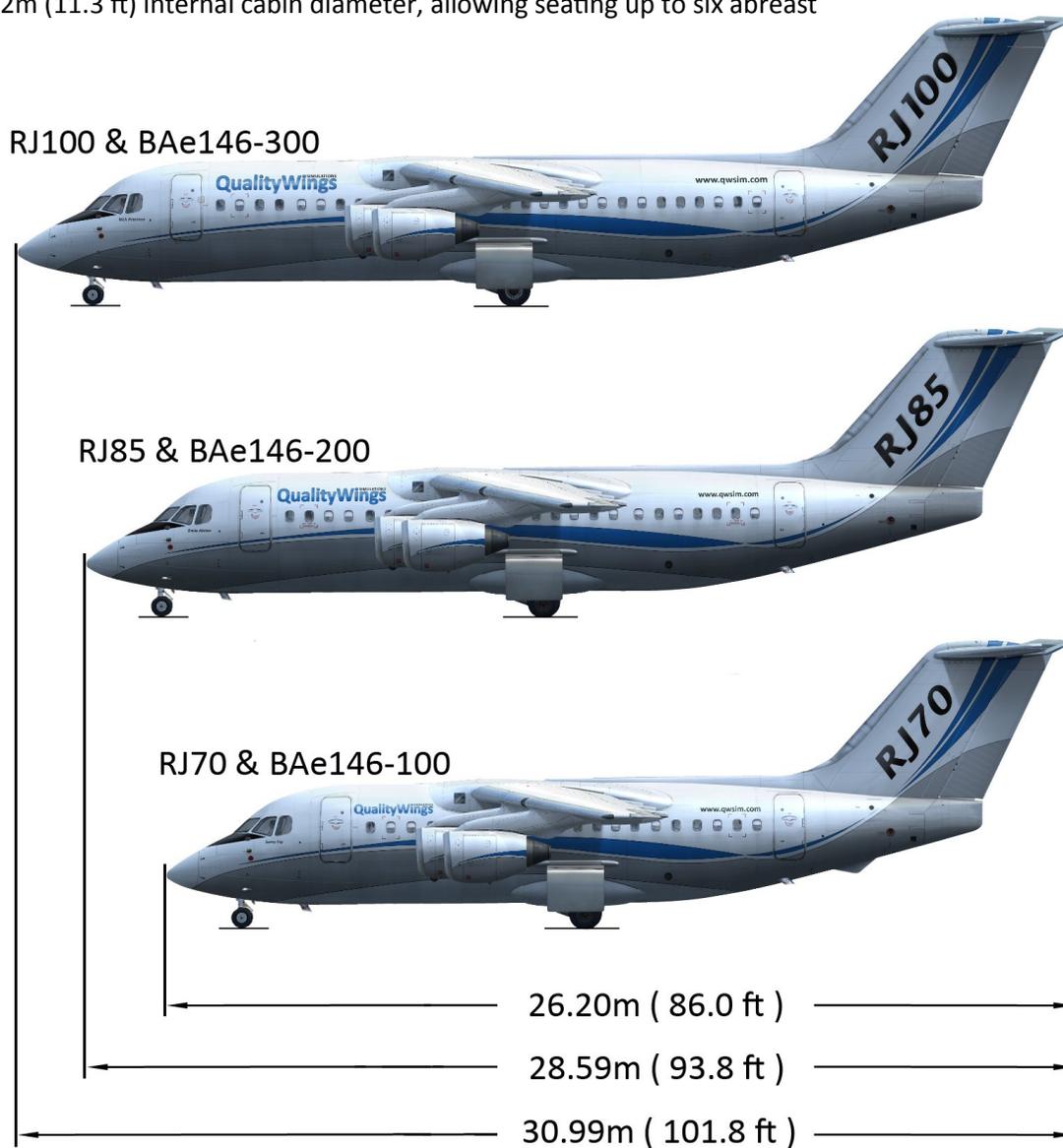
Plan and Front Views

Height and wingspan are the same for all variants.

8.59 m (28.20 ft)

26.20 m (86.0 ft)
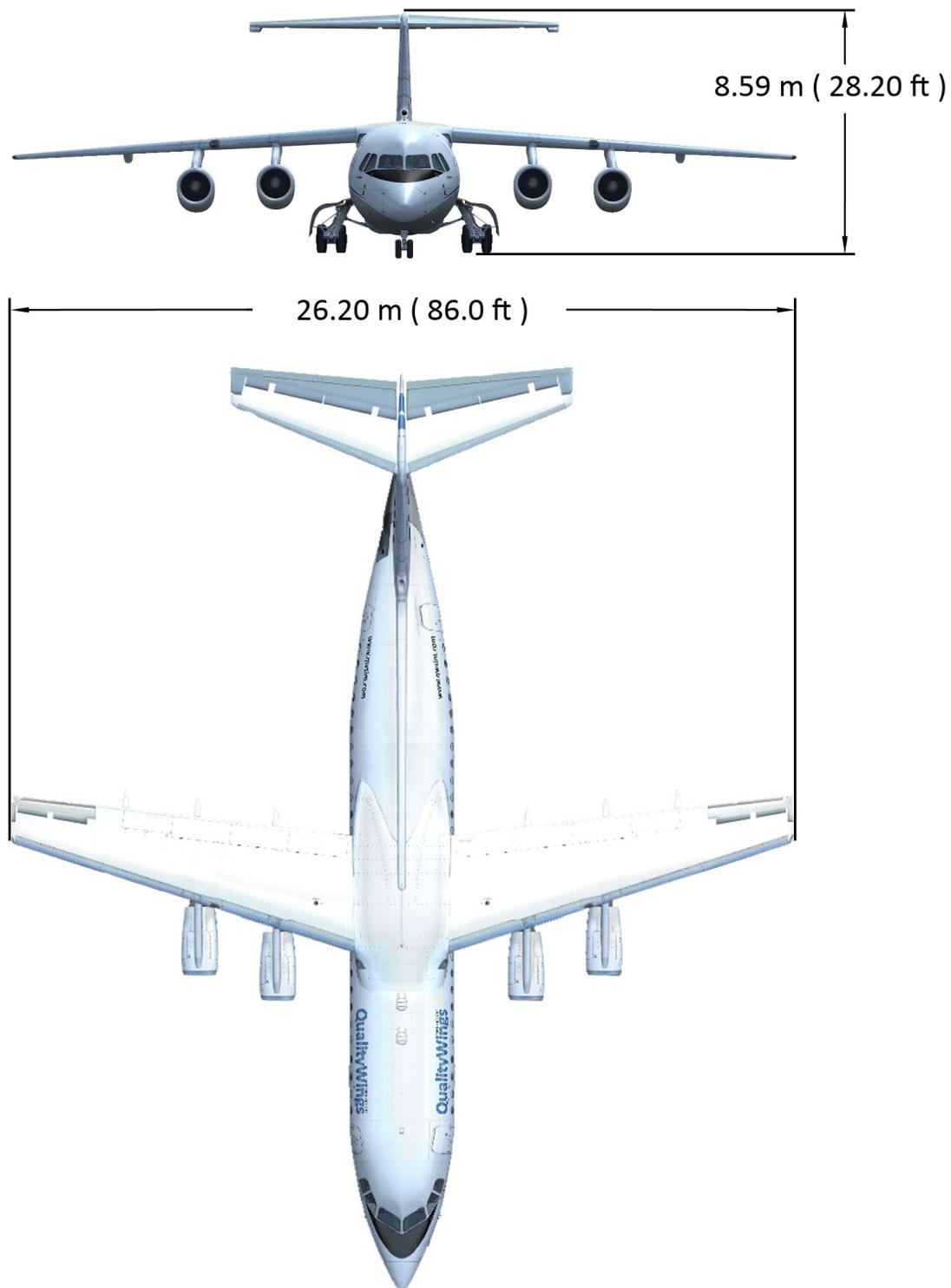
AIRCRAFT CONTROL SURFACES
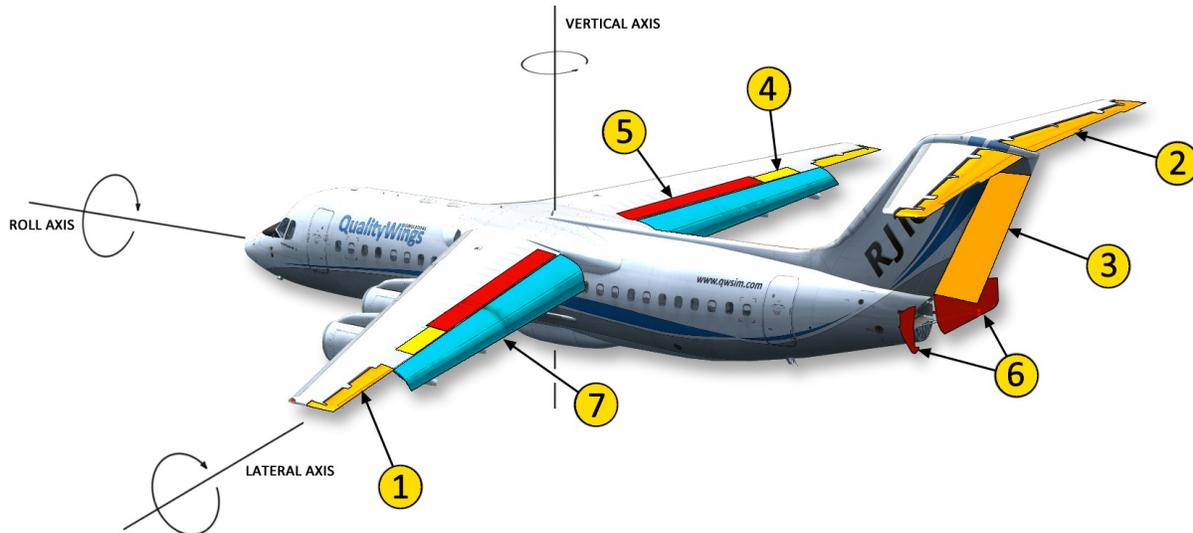
1—Ailerons

Ailerons control the airplanes ROLL along the roll axis. There is one aileron on each wing. The ailerons move in opposite directions of each other to make the aircraft turn. For instance, when you turn your control wheel to the left to start a left turn— the left aileron will raise to "dip" the wing into the turn while the right aileron will "raise" the right wing. A special feature of the Avro RJ and BAe146 series of aircraft is the way the ailerons are controlled. The control wheel is directly connected to small tabs on the trailing edge of the aileron. These tabs move in the opposite direction of the desired aileron deflection. If the air flow around the ailerons is fast enough, the tabs "push" the aileron up or down. That way the pressure on the on the control wheel is relatively low, without the utilization of hydraulic actuators.

2—Elevators

Elevators control the airplanes PITCH along the lateral axis. Pitch is the nose up and Nose Down movement of the aircraft also referred to as the aircrafts attitude. There is one Elevator on each Horizontal Stabilizer. The elevators move together UP or DOWN to make the aircraft climb or descend. For instance, when you push the control column forward, the elevators will move down and make the nose of the aircraft pitch downward. Just like the ailerons, the elevators are tab-controlled. They also serve for trim purposes as the Horizontal Stabilizer of the Avro / BAe146 is not movable.

3—Rudder

A single hydraulically powered rudder controls the airplanes YAW along the Vertical Axis. Yaw is the side to side movement of the aircraft. The rudder is located on the Vertical Stabilizer and is controlled by the Rudder pedals. For instance, pushing the left rudder pedal will move the rudder to the left, causing the nose to turn towards the left. The rudder can be controlled manually by the pilot or automatically by the Autopilot and Yaw Damper.

4—Roll Spoilers

There is one roll spoiler per wing, which assists the ailerons. The roll spoilers can only deflect upwards and are hydraulically powered.

5—Lift Spoilers

The Avro RJ / BAe146 has three hydraulically powered Lift Spoilers per wing. These spoilers only deploy when the airplane is on the ground and are a massive help to slow down the aircraft, not only by increasing drag, but also by destroying lift and thus increasing brake efficiency. Do note that the airplane doesn't have thrust reverser system, which is another proof for the efficiency of this set of spoilers.

6—Airbrake

A hydraulically powered airbrake is located at the tail cone of the plane. It consists of two mechanical linked pedals, which can be deflected up to 60° from the aircraft's centerline. The airbrake is usable on the ground as well as in the air and is usually used to help slowing down the airplane during descent.

7—Flaps

Each wing has a single-piece fowler flap with a tab. The fowler flaps extend not only downwards, but also to the aft, thus increasing wing area. The tab at the trailing edge deflects as the flaps extend to further increase the camber of the wing. The flaps are moved by two hydraulic motors. There are five Flap positions, namely UP, 18, 24, 30 and 33 degrees.

AIRCRAFT DOORS
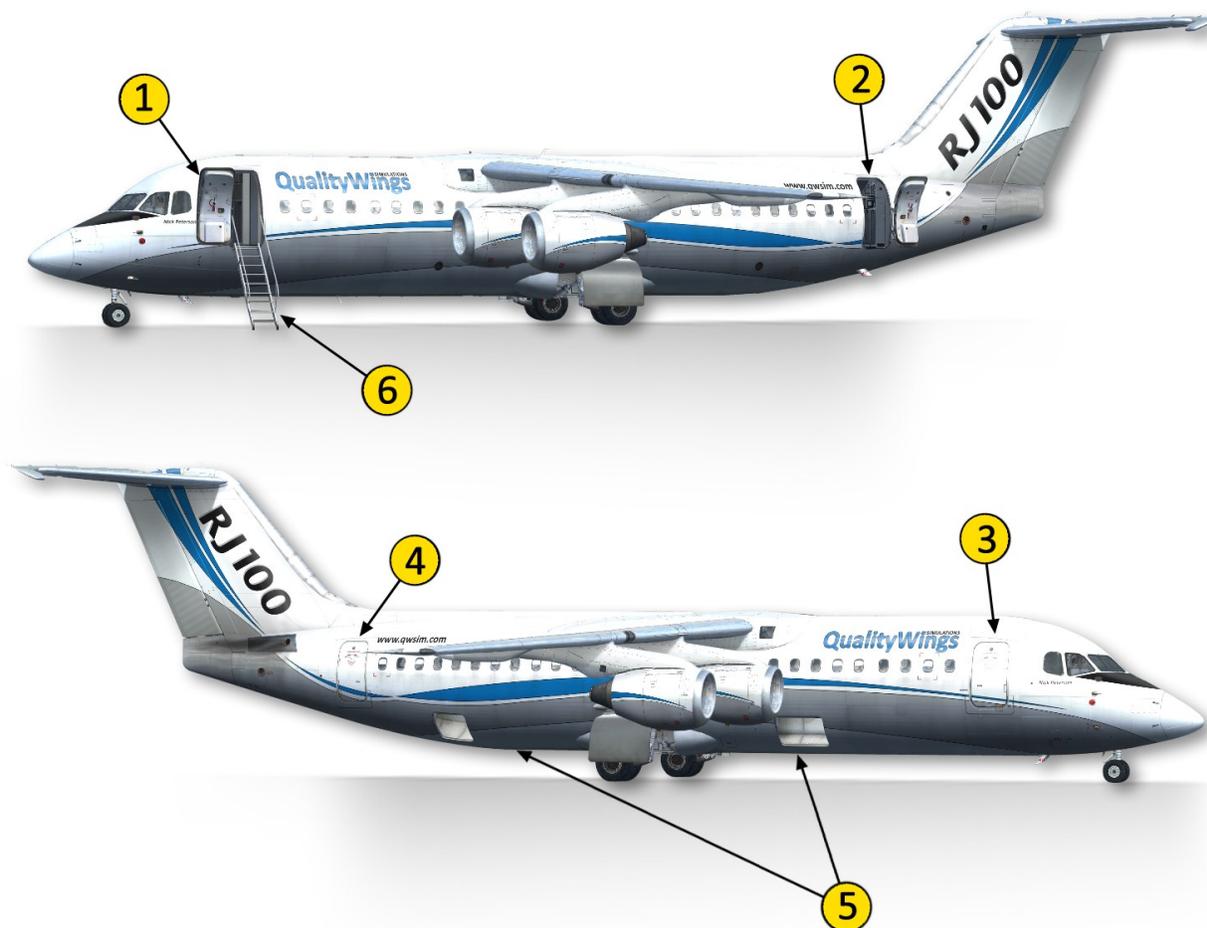
1—L1 Main Entry Door

2—L2 Main Entry Door

3—R1 Galley / Service Door (FSX only)

4—R2 Galley / Service Door (FSX only)

5—Cargo Doors

6—Airstair

All animated doors can be easily controlled via the *QualityWings ControlPanel.*

AIRCRAFT LIGHTING

Exterior Lighting:

1—Wing Navigation Lights
The Navigation Lights are standard red (left) and green (right) position lights.

1—Strobe Lights
White Strobe Lights are located in the same spot as the Navigation Lights on each wing.

2—Tail Navigation Light
As the Wing Navigation Lights are only forward facing, there is also a white Navigation Light on the Tail Cone to ensure visibility from behind.

2—Tail Strobe Light
Just like on the Wing, there is also a strobe light located on the Tail.

3—Beacon Lights
Red Anti-Collision Lights are located on the top and bottom of the fuselage.

4—Landing / Taxi Lights
One Landing and one Taxi Light is fitted to each wing. Landing and Taxi Lights share the same housing and cannot be used together.

5—Runway Turnoff Lights
One Runway Turnoff Light is located on each side of the wing-to-body fairing. These lights cast an angled lights splash on the ground, improving visibility to the sides of the aircraft.

5—Wing Inspection Lights
One Wing Inspection Light is located on each side of the wing-to-body fairing and illuminates the leading edge of the wing.

Interior Lighting:

There are five distinctive areas of Night Lighting in the Cockpit:
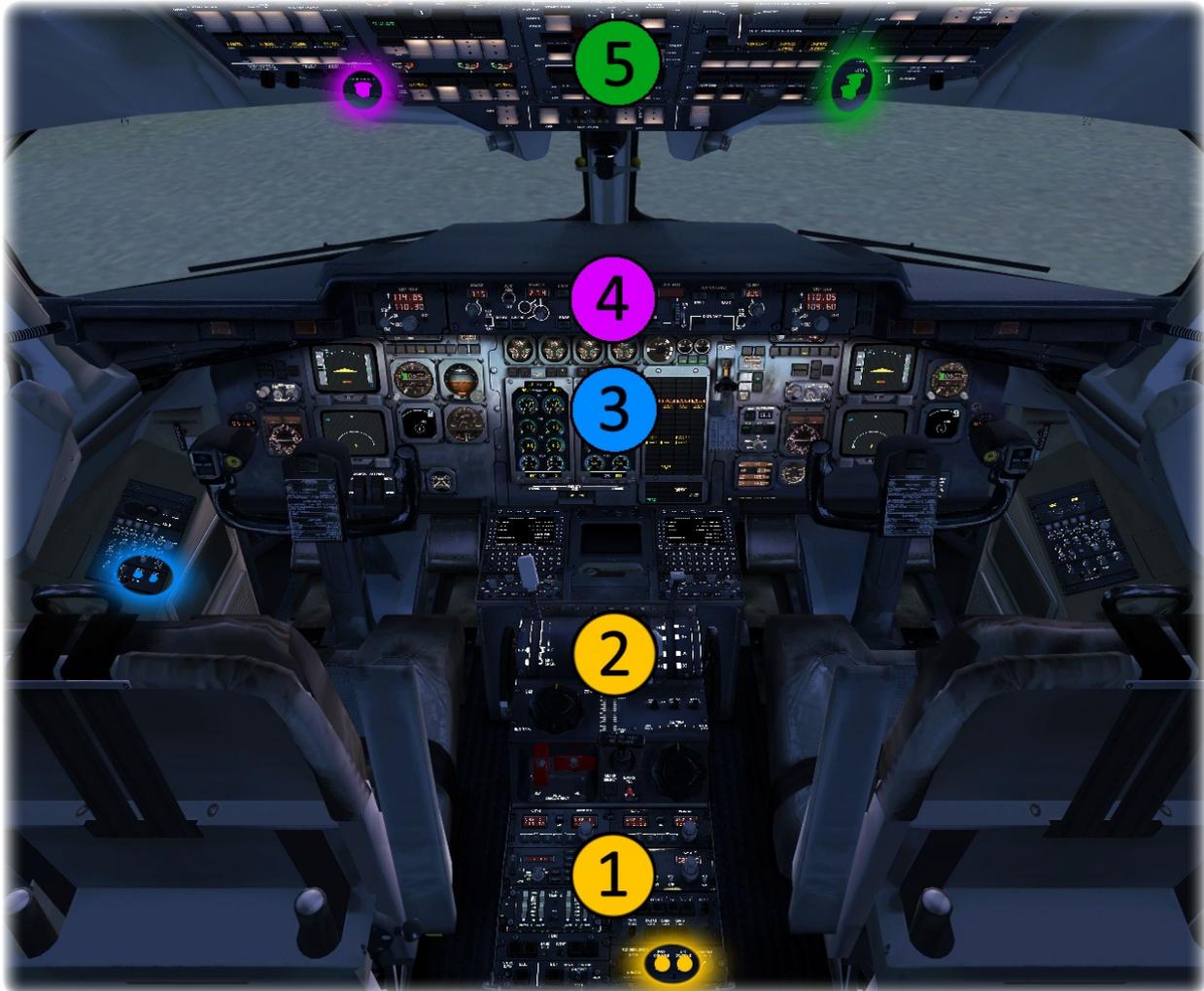
1—**Aft Console**

2—**Forward Console**

3—**Main Panel**

4—**Glareshield / Mode Control Panel**

5—**Overhead Panel**

You can see the respective switches for each area highlighted on the figure above. The Main Panel actually has two separate knobs. One for the dimmable Flood Light and one for the Text Backlight.

Do note that the Dome Light is not shown in this figure. The Dome light can be switched on by clicking the "Entry Light" Switch on the LIGHTS & NOTICES Section of the Overhead Panel.

—INTENTIONALLY LEFT BLANK—

FLIGHT MANUAL

INTRODUCTION

The history of the aircraft is fun to know, but it doesn't help you get the plane in the air. This is what this part of the manual is for. Here you'll find descriptions for each of the simulated systems; their location in the cockpit, the way to read them and their function. Note that the "how's and when's" are reserved for the tutorial flight. In the descriptions, any differences between aircraft types are mentioned. Before we get into the systems though, let us welcome you to the flightdeck and give you a quick tour of the cockpit.

WELCOME TO THE FLIGHTDECK

You find yourself sitting in the left seat, which is where you'll spend most, if not all of your time. Looking straight ahead, you see the main instrument panel.

VC view, looking straight ahead, sitting in the Avro RJ 100.

This is what you will be seeing most of the time. The main instrument panel can be thought of as being three distinct panels joined together to form one big panel. As such, the left and right panels contain the primary flight instruments. The EADI is easily discovered in the left and right panels, but the EHSI is partly obscured due to the yoke. To the right are the altimeter, TCAS and standby gauges, and to the left you see the DBI. In the center panel we see the engine instruments and annunciation panels. The annunciation panels are two panels: the Central Warning Panel (CWP) and Central Status Panel (CSP). Above the center portion of the main instrument panel we find the glareshield, which is similarly split in three different panels. Here, the left and right portions include annunciator panels, while the center portion contains the Mode Control Panel, or MCP. This is what houses the flight guidance system, or autopilot. This should be familiar in layout and function for those already having flown jetliners in Flight Simulator before.

It is obvious that the main instrument panel is your main source of information, what with all the vital instruments placed here. However, as important as it is, it is not the place from where most systems are controlled. For this we tilt our view upwards, and look at the overhead panel.

The Avro RJ overhead panel

The overhead panel is the place where you will click switches, rotate knobs and press buttons. It is the place from which all systems are controlled that are not necessary for flying the plane. Thus they are given a place which is easily accessible yet not in the way when flying the plane. But what if a system fails? You won't be looking at the overhead, so chances are you'll miss any failures. For this BAe thought of two solutions.

THE DARK COCKPIT CONCEPT

One of the solutions BAe introduced in this cockpit is the "dark cockpit" concept. This concept emphasizes the principle that if everything works okay and is configured properly, then there are no annunciator lights turned on. This is unlike Boeing, where turning on systems produces a burning light. In the BAe 146 and Avro series, it is the other way around: if a vital system for flight is turned off or is malfunctioning, the light will turn on. When it works okay, the light will turn off. Other companies have used this concept also, like Fokker in its Fokker 70/100 jetliners and Airbus in all of its aircraft. The ultimate goal is to make sure that if something goes wrong, the pilot's attention will be drawn to it. You can imagine that one light turning on in an otherwise dark overhead will be easier to spot than a light turning on in a sea of other lights signifying correct system operation.

THE OTHER SOLUTION

It was said BAe introduced two solutions to make sure problems are notified to the crew visually. The other one is probably the simplest and can be found on every plane in one way or another: the annunciator panel.

The CWP and CSP

The annunciator panel is just that: a panel containing a huge array of annunciator lights. It's basically split into two panels, introduced before: the CWP, which alerts the crew to possible failures or other abnormal situations, and the CSP, which alerts the crew to the status of systems. Normally, most of them are dark. However, if something unusual happens, then the lights turn on. For example if your engines are turned off. Since this is an abnormal situation for normal flying conditions, the annunciator lights were turned on. This way, the pilot knows that something has gone wrong, without looking at the overhead panel.

CONTINUING THE TOUR

Turning our attention back to the overhead panel, let's see what we can find here. There are light switches at the very front. Above it we find ice protection controls, and the engine controls (ignition switches and such). At the very left we see the fuel panel, and just to the right of it the electrical panel. The big red handles are for fire protection. To the right of the fire handles we can find air conditioning controls and more light related controls. As such, just about every system's state on the plane can be modified from this "nerve center".

The overhead panel is mostly passive in operation, however. Unlike the main instrument panel, where indicators are constantly changing and require your constant attention, the overhead panel follows the philosophy of "set it and leave it". That is, until you have to reset something of course. There are two other panels in this cockpit that fall in between the activity of the main instrument panel and the over-head panel and are located on the pedestal. These are the radio panel (also called "radio stack") and the throttle quadrant. Located just behind the throttle quadrant we can also find the interface with which you, the pilot, talk to the "brain" of the plane: the Control Display Unit, or CDU for short.

The CDU, throttle quadrant and radio stack.

The design of the pedestal is not surprising and closely resembles other aircraft on the market, and for good reason: this works. The throttle quadrant is positioned in such a way that access is easy, yet isn't in the way when working with the radio stack. The radio stack, positioned at the back, is your interface to the world outside the aircraft and thus is probably a very important panel. The CDU, however, is the brain of the plane. It is what makes the auto pilot a true autopilot by regulating everything for you without any real pilot intervention being necessary. It's your entry into the plane's Flight Management System (FMS), and thus lets you enter various data, including the route to follow, speed and altitude restrictions and performance data, like fuel load, gross weight and zero fuel weight.

INTRODUCING THE 2D PANELS

The QualityWings Ultimate 146 Collection sports a full set of the 2D panels, alongside the high quality VC. Via the 2D panels, you'll be able to easily access all relevant systems. When describing the various systems, the 2D panels will be used to introduce them and signify their locations. Note that this is due to their ease of use, easy access and overall clarity. There is no difference in simulation between the VC and 2D panel.

AVRO RJ

Avro RJ widescreen main panel shown

Avro RJ Upper Overhead Panel (Shift+3)

Avro RJ Upper Overhead Panel (Shift+2)
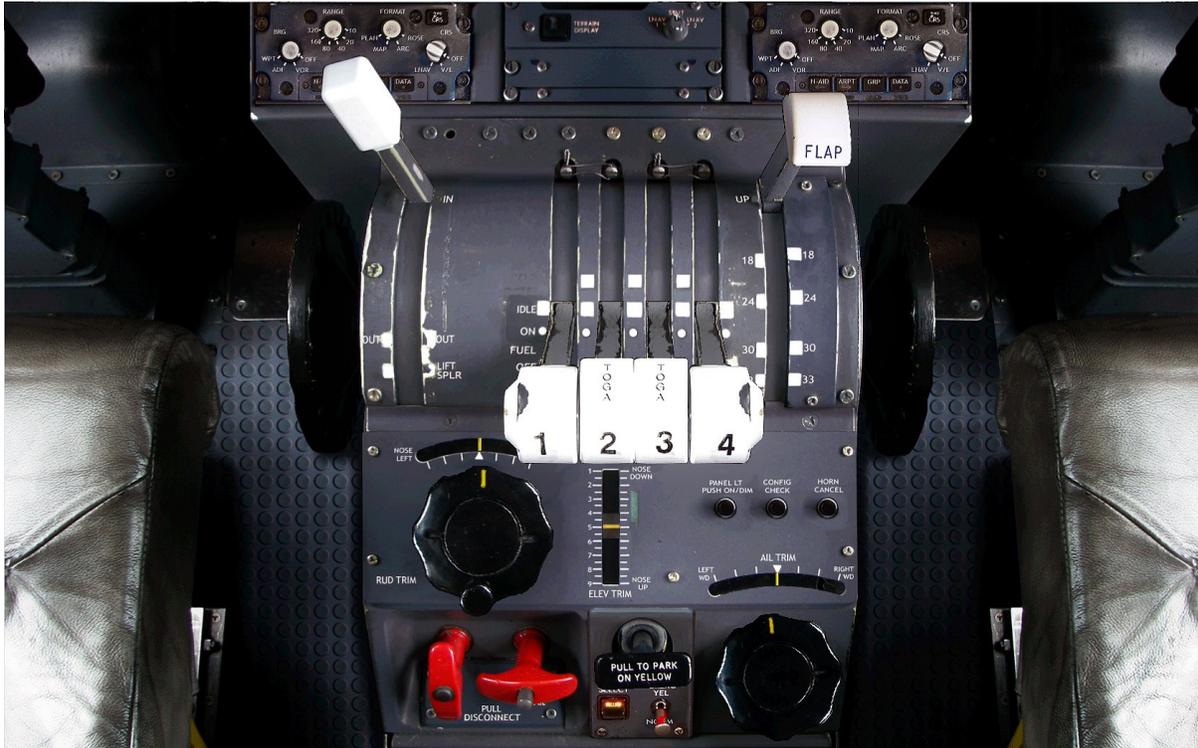
Avro RJ Throttle Quadrant (Shift+4)
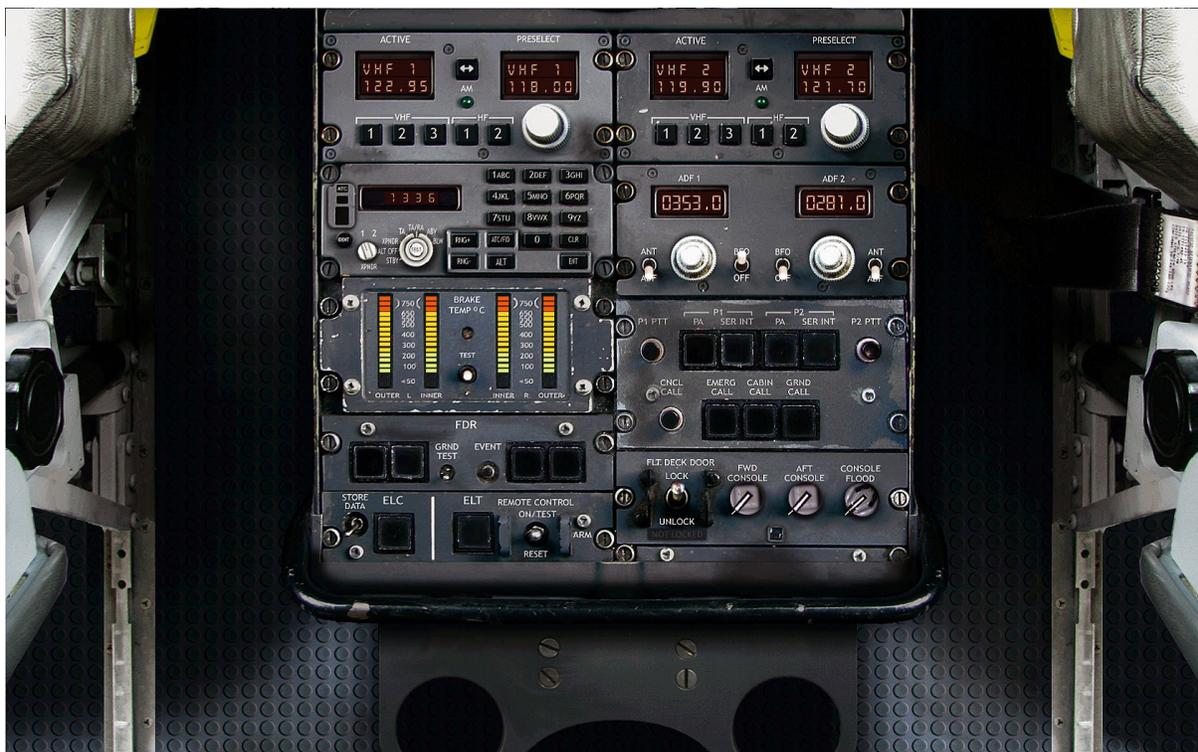
Avro RJ Pedestal (Shift+5)

Avro RJ GNLU910 FMS and EHSI Controls
(Shift+6)

Avro RJ Audio Panel and IRS Controls
(Shift + 7)

Avro RJ Thrust Rating Panel and Speedcard

—INTENTIONALLY LEFT BLANK—

SYSTEM DESCRIPTIONS

SYSTEM DESCRIPTIONS

From here onwards the systems will be described. The structure of each chapter is simple:
- Location in the VC
        - 2D panel
                - Subpanel
                        - Button/dial/knob/switch/meter

There are five main panels which will be discussed:

- Overhead panel

- Main instrument panel

- Pedestal

- Audio Panel

- Flight Management System

Alongside describing the function of each button, we attempted to give an overview of the system that goes deeper into how the system functions on this plane.
This info might be overwhelming for beginners however, so if you feel uncomfortable with this load of new information, don't worry. Each chapter has a green highlighted "HOW TO USE" section. In this section we briefly tell you everything you need to know in order to operate the system correctly.

While reading this part of the user manual, remember one thing that will ease finding information in the future:

Most system's functioning and structure will be dealt with in their fullest in the related overhead sub-panel topic.

As such, whenever you wish to get information on a specific aircraft system, always refer to the related overhead subpanel first! If a system's part is not covered in the context of the system's overhead sub-panel (the engines are a good example of this), a reference will be included to the appropriate topic in the user manual.

OVERHEAD PANEL

The Overhead Panel in the Virtual Cockpit

Overhead Panel in the 2D Panel *(Shift+2 and Shift+3)*
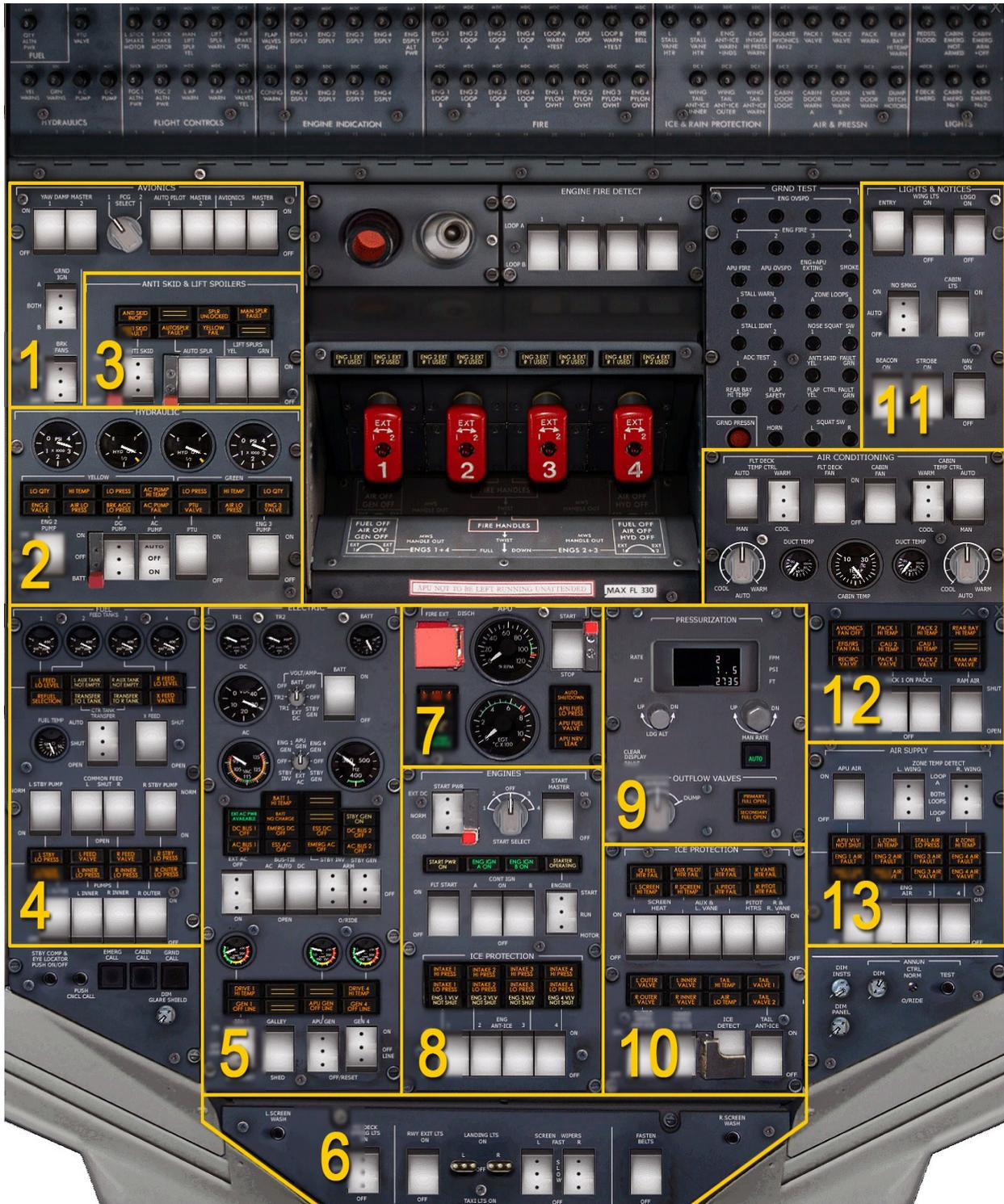
The overhead is sectioned into four columns, within each column are a different number of subpanels, grouping together the buttons, switches, knobs, lights and gauges that represent the status and control of a particular system.
What system they represent is written at the top of each subpanel in big, white lettering.
The various systems on the overhead panel are the following (compare to figure on the previous page).

1. Avionics subpanel

2. Hydraulics subpanel

3. Anti-Skid and Lift Spoilers subpanel

4. Fuel subpanel

5. Electrical subpanel

6. Lights subpanel

7. APU subpanel

8. Engines subpanel

9. Pressurization subpanel

10. Ice protection subpanel

11. Lights and notices subpanel

12. Air conditioning subpanel

13. Air supply subpanel

So as you can see, there is definitely a system to be found in all this mess. All you have to do to find a system is find the correct label and you'll know you've found all relevant instruments for that system.

AVIONICS
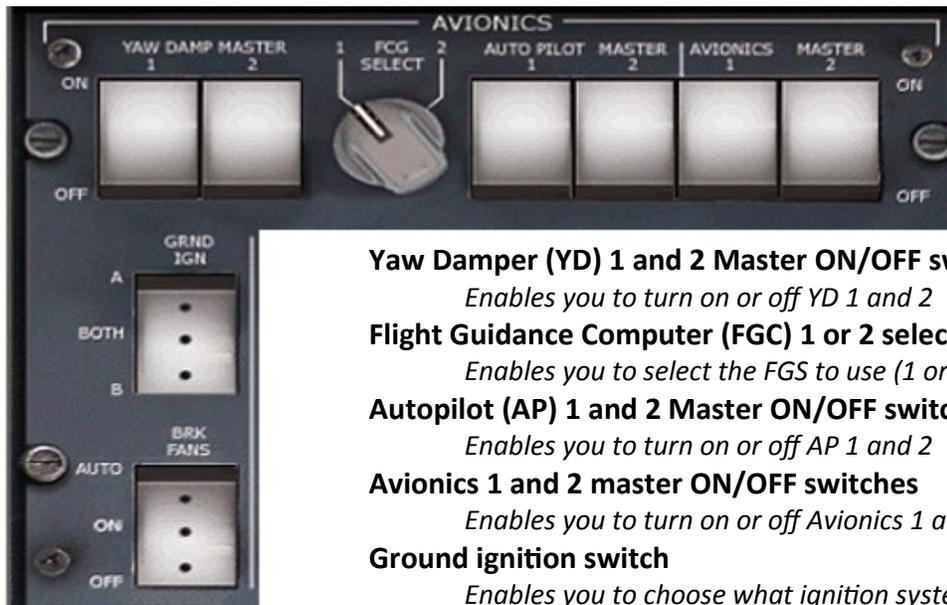
Yaw Damper (YD) 1 and 2 Master ON/OFF switches
Enables you to turn on or off YD 1 and 2
Flight Guidance Computer (FGC) 1 or 2 selection knob
Enables you to select the FGS to use (1 or 2)
Autopilot (AP) 1 and 2 Master ON/OFF switches
Enables you to turn on or off AP 1 and 2
Avionics 1 and 2 master ON/OFF switches
Enables you to turn on or off Avionics 1 and 2
Ground ignition switch
Enables you to choose what ignition system to use while on the ground (A, B or Both)
Brake fans switch
Enables you to choose whether brake fans should be OFF, ON, or AUTO

HOW TO USE

-Select the YAW DAMP, AUTOPILOT and AVIONICS MASTER Switches to ON, when you receive the aircraft. Switch them OFF again, when leaving.
-It is recommended to set FGC SELECT to 1 on odd, and to 2 on even days.
-It is also recommended to set GRND IGN to A on odd, and to B on even days.
-Switch on the Brake Fans when the aircraft is on the ground and shortly prior to landing.

SYSTEM DESCRIPTION

The avionics subpanel is the main subpanel to turn ON or OFF the avionics and autopilot systems.

The rotary knob is the FGC selection knob, and enables the crew to choose the FGC system to be used. The selected FGC will carry out all FGS (Flight Guidance System) functions, however it will be assisted by the second FGC in yaw damping.
The final two rocker switches don't really have anything to do with the avionics.

The ground ignition switch lets the crew select which igniter shall be used during engine start.
One can use igniter A, B, or both. Usually this is down to the company rules.

The other switch is the one for the brake fans on the main landing gear.
You will notice when they are running because of a green notification on the CSP: **BRK FANS SEL ON**

HYDRAULICS

Hydraulic system pressure gauges

A dedicated gauge for each system showing the hydraulic pressure of that hydraulic system

Reservoir quantity gauges

A dedicated gauge for each system showing the quantity of hydraulic fluid in each hydraulic system's reservoir

LO QTY

Annunciator light that turns ON when fluid quantity in the respective reservoir is at or below the reservoir's reserve level

HI TEMP

Annunciator light that turns ON if the temperature leaving the system's respective reservoir is too hot

LO PRESS

Annunciator light that turns ON if the pressure in the respective system falls below 1500 psi

ENG 2 VALVE / ENG 3 VALVE

Annunciator lights showing that the respective valve does not match the respective switch's position

AIR LO PRESS

Annunciator light that turns ON when the air pressure in the respective system is too low

BRK ACC LO PRESS

Brake Accumulator Pressure light turns ON when the brake accumulator pressure is below 2500 psi

AC PUMP HI TEMP

Annunciator light that turns ON when the AC pump motor's temperature is too high

AC PUMP FAIL

Annunciator light that turns ON if the output pressure of the AC pump does not agree with the electric command that is given

PTU VALVE

Annunciator light that turns ON if the valve is not in the position selected with the PTU Switch

Engine 2 pump ON/OFF switch

Switch that turns engine number 2's isolation valve ON or OFF

DC Pump ON/OFF/BATT switch

Turns the DC pump ON, OFF or sets it to power provided by the Battery

AC Pump AUTO/OFF/ON switch

Switch that sets the AC pump ON, OFF, or AUTO. At AUTO, it will automatically turn ON if either one of the engine-driven pumps fail

PTU ON/OFF switch

Switch to turn the PTU valve ON or OFF

Engine 3 pump ON/OFF switch

Switch that turns engine number 3's isolation valve ON or OFF

HOW TO USE

Before Start:

All Switches OFF

After Start:

*Switch on the **PTU** and the **Eng 2 / Eng 3 Pumps**. Put the **AC PUMP** Switch to AUTO*

Shutdown:

All Switches OFF

SYSTEM DESCRIPTION

The BAe-146/Avro RJ series has two hydraulic systems, called yellow and green. Each of these hydraulic systems has some common components:

The ***reservoirs*** hold the hydraulic fluid that is not presently used within the hydraulic system.

The ***pumps*** draw hydraulic fluid out of the hydraulic fluid reservoir and pump it around the system. While doing that they pressurize the fluid so as to provide various hydraulic services (such as retracting the landing gear, for example). There are main and auxiliary pumps for each hydraulic system, and the yellow system also has an back-up pump.

The ***accumulators*** are interim "reservoirs" where pressurized hydraulic fluid can accumulate. They store pressurized hydraulic fluid and thus form a sort of reserve for pressurized hydraulic fluid.

The ***Hydraulic subpanel*** on the overhead panel in the flightdeck contains all the gauges, annunciator lights and switches to operate the hydraulic system. When any of these lights illuminates, the annunciation light HYD on the CWP will also illuminate to draw attention to the hydraulics panel.

These various components are placed in series so as to provide a safe and reliable way in which hydraulic pressure can be used to move mechanical parts, such as the landing gear, flaps and also airstairs if fitted on the aircraft.

The hydraulic reservoirs

The reservoirs are the main "basin" in which the hydraulic fluid resides. Fluid that is not used is stored here, and the fluid will also be returned to the reservoir if not needed at that time. Empty space in the reservoirs is filled by air, supplied by the respective engine, at a pressure of 50 psi. If the pressure of the air falls below 50 psi, the annunciator light LOW AIR PRESS will illuminate on the overhead panel's hydraulics subpanel. If the fluid quantity is very low, a LO QTY annunciator light will illuminate on hydraulics subpanel. The exact amount of fluid quantity can be seen on the fluid quantity gauge on the hydraulics subpanel. Note that for the LOW AIR PRESS and LO QTY annunciator lights there is a delay of 10 seconds before the annunciation HYD# illuminates on the CWP. This was done because these annunciations can also be triggered when there is a sudden, big use of the hydraulics system. For example when the gear and flaps are all extended at once. Finally, if the fluid that leaves the reservoir is very hot (above 90°C), a HI TEMP light will illuminate on the hydraulics subpanel. The main cause for each of these lights to illuminate will be a leak somewhere in the hydraulic system.

The hydraulic pumps

The main pumps are engine driven and draw fluid out of the reservoir. However, if these pumps fail due to a mechanical fault in the pumps themselves or due to engine number 2 or 3 failing (for the yellow pump is driven by engine 2 and the green pump by engine 3), there are auxiliary pumps to take over their action.

The auxiliary pump of the yellow system is driven by AC bus 1 and is therefore called the "AC pump". There is a special switch on the hydraulics subpanel to turn the AC pump ON, OFF or enable it AUTOmatically as soon as the main yellow pump fails.

The auxiliary pump of the green system is called the Power Transfer Unit (PTU): a motor that itself is hydraulically driven by the yellow system that mechanically drives the PTU. The PTU can be enabled from the flight deck by using the PTU switch on the hydraulics subpanel. It can be turned either ON or OFF. There is no AUTO function like with the AC pump. When you do turn ON the PTU, you effectively open the PTU Valve (figure 2). This enables fluid to reach the PTU motor so that it can be hydraulically powered and drive the PTU pump. The PTU then pressurizes the green hydraulic system up to 2500psi.

Note all this means that if all the yellow pumps have failed, and the green main engine-driven pump fails also, the PTU will not be able to pump. However, the yellow system has a third pump, an emergency back-up pump: the DC pump. The DC pump is an alternative emergency source of hydraulic power and is used for emergency gear lowering and braking. Its fluid comes from a dedicated part of the yellow reservoir that can't be used by the other pumps. As a matter of fact, it was never designed to power anything but that which is vital during an emergency, as can be seen of its placement in the system: well after most of the services the yellow system power. On the hydraulics subpanel on the overhead panel there is a switch to turn the DC pump ON, OFF or put it on Emergency BATTery Power.

The hydraulic accumulators

The last of the important components is the accumulator. The accumulator can be seen at various positions within the hydraulic system in figure 2. As was said earlier, the accumulator is basically what its name suggests: a place where hydraulic fluid accumulates when it's not of direct use in the system, thus providing immediate, pressurized fluid when it is necessary. How this is done can be seen in figure 1, but basically it involves a cylinder with a piston in it, and counter-pressure produced by nitrogen.
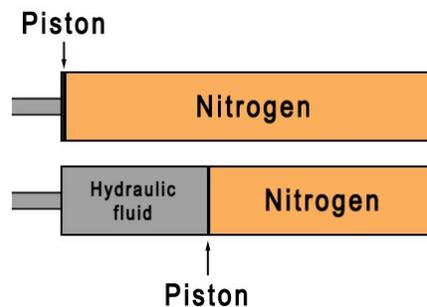
Figure 1: Accumulator function

The accumulator is arranged as follows: The cylinder is divided into two compartments by a piston that can be move somewhat freely through the accumulator. The left compartment is in direct contact with the rest of the hydraulic system, and hydraulic fluid can flow into it. The right compartment is filled with nitrogen however. The nitrogen is what keeps the hydraulic fluid pressurized, because it provides a *counter pressure*. Let's take a look at figure 1 now.

The top schematic in figure 1 shows a hydraulic fluid pressure of 0 psi. As a result, the pressure of the nitrogen on the piston causes the piston to move to the full left because there is nothing in the left compartment to counter the movement of the piston. However, as soon as hydraulic fluid enters the hydraulic system by activation of the main or auxiliary pumps, it will also enter the accumulator and the piston will be pushed back. This process can be seen in the lower schematic in figure 1. However, this causes the nitrogen to be pushed back, and thus in the nitrogen compartment the pressure rises. Above 1000 psi, the nitrogen's pressure rises in equal measure as the hydraulic fluid pressure rises. The pressure of the nitrogen can be read on a pressure gauge attached to the accumulator, and thus hydraulic fluid pressure can be checked.

Note that not all accumulators are depicted in figure 2. In principle the green and yellow systems each have their own accumulator, but additional accumulators may be installed for the airstairs if these are fitted.
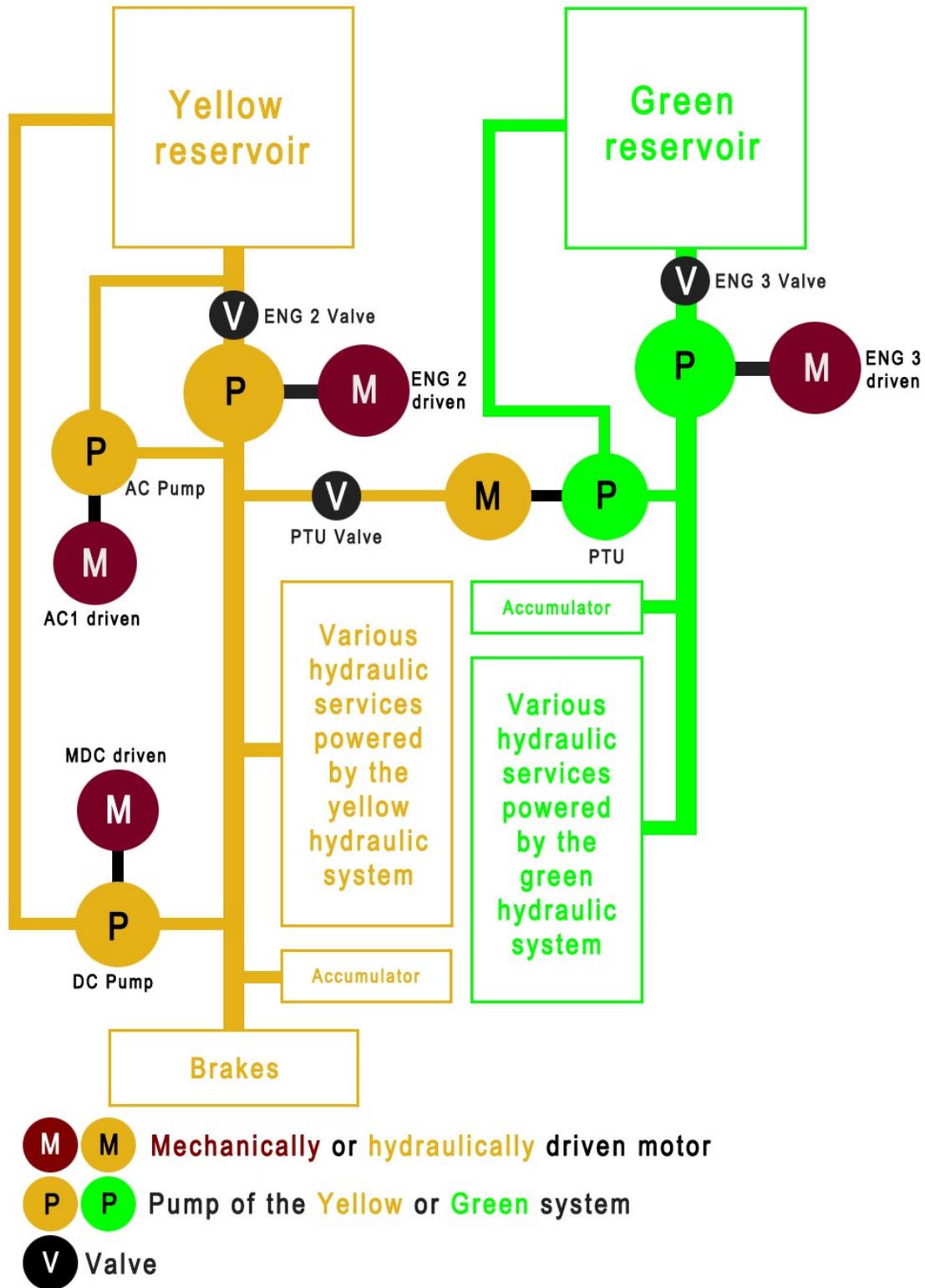
Figure 2: Simplified schematic of the Hydraulics system

ANTI SKID & LIFT SPOILERS

Anti-skid ON/OFF/BATT selector switch

Enables you to turn the anti-skid ON, OFF, or have it powered by the
Emergency Battery Bus (EMERG BATT BUS)

Auto Spoiler ON/OFF selector switch

*Enables you to turn the Auto Spoiler ON or OFF **(Not available in the BAe146)***

Lift spoilers Yellow and Green ON/OFF switches

Enables you to turn both Lift Spoiler systems ON or OFF

HOW TO USE

This subpanel is one that is checked during the Flight Deck Safety part of the checklist, and afterwards is never looked at again. All switches should be set to ON. When checked and this does not seem to be the case, set them to ON. Any annunciator lights might be lit due to the unavailability of hydraulic power at this stage of the flight, but during the remainder of the flight you will most probably not touch these switches again.

SYSTEM DESCRIPTION

The Anti-skid and Lift Spoilers overhead subpanel basically comprises two independent systems that as such fall into two different categories. The Anti-Skid portion of this subpanel belongs to the Landing Gear systems and it is designed to make sure that when the plane brakes heavily, the wheels do not lock. When a wheel locks, steering becomes more difficult and braking efficiency is reduced.
The rocker switch for the anti-skid system can be positioned to ON to turn it ON (and be powered by DC BUS 2), OFF, or BATT to have it powered by the Emergency Battery Bus.
See the next page to find out more about the Lift Spoilers.

The Lift Spoilers

The Lift Spoilers are a completely different system and are actually part of the Flight Controls.
Their main function is to decrease lift and they are only used on the ground. There is a safety mechanism in place that disables deployment in the air.

Figure 3: Lift spoilers: where, and by what hydraulic system (green or yellow)

There are three lift spoilers on each wing, termed outer, middle and inner (Figure 3). The inner spoilers are known as the yellow spoilers, whereas the middle and outer lift spoilers are knows as the green spoilers.
This is because they are called after the hydraulic system that powers them: yellow and green. Not unsurprisingly, these colors also match the rocker switches on the Anti-Skid and Lift Spoilers subpanel of the overhead panel. The two rocker switches, termed yellow and green, supply power to the yellow and green lift spoilers.
The switch next to the Lift Spoilers rocker switches is the Auto Spoiler rocker switch.
The Auto Spoiler rocker switch features two positions: ON turns the auto spoilers ON and thus arms the lift spoilers for automatic deployment upon landing, OFF disables the aforementioned function. Note that for this to work, the previously mentioned Yellow and Green Lift Spoiler rocker switches have to be set to ON in order to supply the hydraulic components of the spoiler system with power, but it is not the only condition that has to be met. Furthermore the following conditions must be met for an automatic spoiler deployment:

> -The *main landing gear wheels must be turning*
> -*At least three of the thrust levers must be at IDLE*
> -*The Anti-Skid system must be ON and serviceable*

NOTE: The BAe146 variants to do not feature an automatic Lift Spoiler deployment.
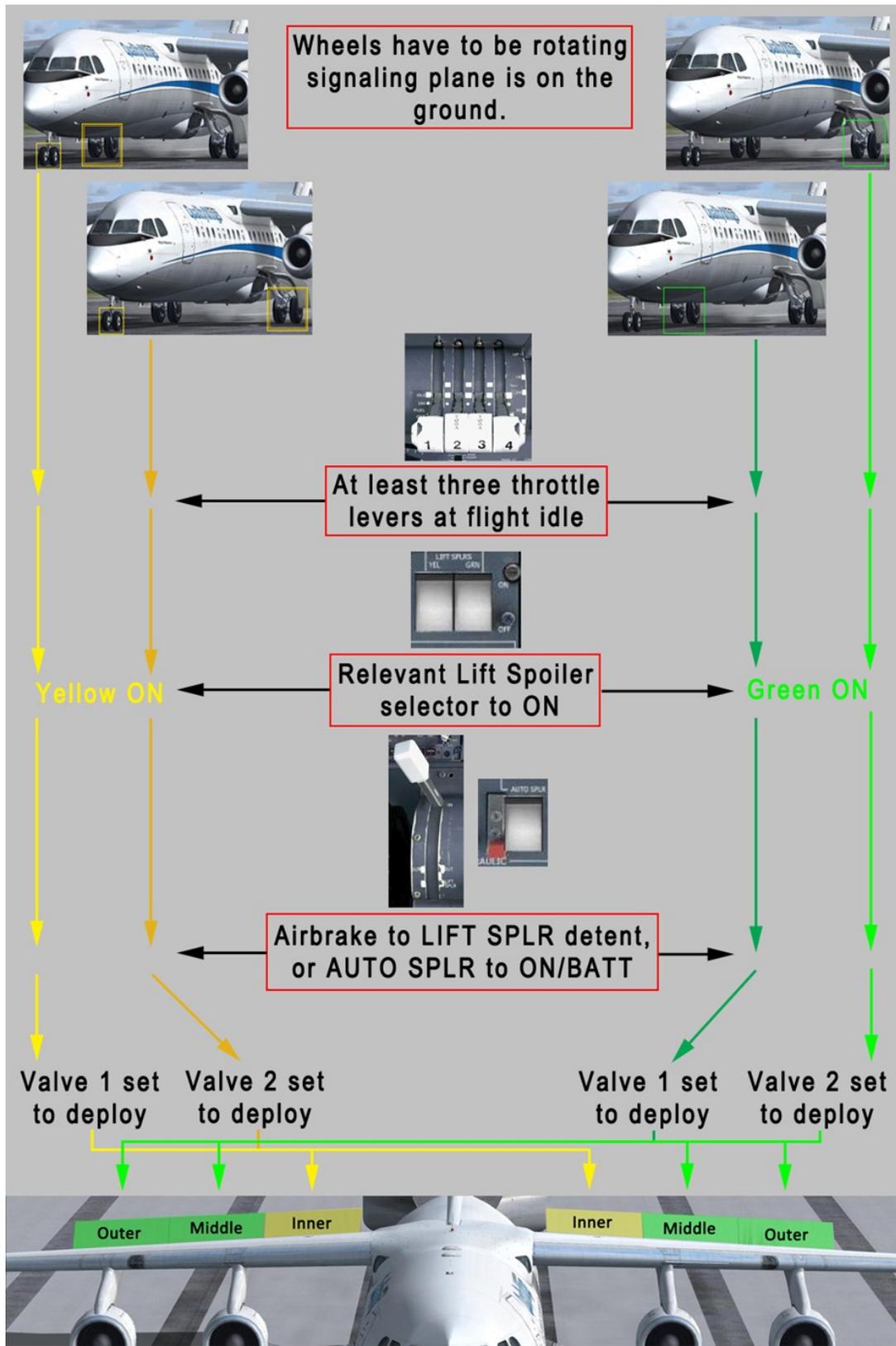
Figure 4: Simplified schematic for the lift spoiler deployment (only applies to Avro RJ)

FUEL

Feed tank quantity indicators 1 - 4

Indicators showing the fuel level in each tank

L/R FEED LO LEVEL

Annunciation lights signaling that the feed tanks are not full. L FEED LO LEVEL is for tank 1 and 2, R FEED LO LEVEL for tank 3 and 4. Only one tank needn't be full for the correspondent light to turn ON

REFUEL SELECTED

Turns out to signal that either the refuel door is open, or the refuel door is closed but the refuel master switch is ON

L/R AUX TANK NOT EMPTY

Annunciation lights signaling that the left or right auxiliary tanks still contain fuel

TRANSFER TO L/R TANK

Annunciation lights signaling that the left or right transfer valves are open

X FEED VALVE

Annunciation light signaling that the cross-feed valve is not in the selected position

Fuel temperature indicator

Shows the temperature of the right inner fuel tank (tank 3)

CTR TANK TRANSFER switch

Switch controlling the transfer valves through which fuel can be transferred to from the center tank to the wings. At OPEN, both valves are OPEN, at SHUT both are SHUT, at AUTO and on the ground they are SHUT. At AUTO and in the air, the valve for the associated wing is OPEN unless the associated wing tank high level switch is in the HIGH position, or the associated center tank low level switch is in the LOW LEVEL state

X FEED SHUT/OPEN switch

OPENs or SHUTs the cross-feed valve

L/R STBY PUMP switches

Switches to activate the left and right standby pumps. At ON, both will run. At NORM, standby pump 1 will run if AC BUS 1 fails, and right will run if AC BUS 2 fails

L/R COMMON FEED switches

Switches to OPEN or SHUT the associated common feed valve

L/R STBY LO PRESS

Annunciation lights signaling that the associated standby pump's pressure is low while it is supposed to run

L/R OUTER/INNER LO PRESS

Annunciation lights signaling low pressure in their associated pump

L/R OUTER/INNER LO PRESS
> *Annunciation lights signaling low pressure in their associated pump*

L/R FEED VALVE
> *Annunciation lights that signal that the valve is not in the selected position*

L/R OUTER/INNER PUMPS switches
> *Switches to turn the fuel pumps ON or OFF*

HOW TO USE

The fuel system is mostly a set-and-forget system. If you set everything up correctly during the initial stages of flight, you don't have to touch it anymore until engine shutdown, but we do recommend at least giving Figure 8 a look, as it shows a complete schematic of the fuel system, with the positions of the various tanks, valves and pumps. As such it may help you understand the position of all components inside the fuel system. As for the operation of the system, here's what you need to know:

During the Flight Deck Safety checklist:
> **CTR TANK TRANSFER** switch set to AUTO if fuel is in the center tank, otherwise set to SHUT
> **X FEED** switch set to SHUT
> **L/R STBY PUMPS** switches set to NORM
> **COMMON FEED L/R** switches set to SHUT

Before engine start:
> **INNER** and **OUTER PUMP** switches set to ON
>> *All fuel panel annunciators and the* **FUEL LO PRESS** *captions on the CWP should be extinguished! NOTE: The white L/R AUX TANK NOT EMPTY annunciators may still be lit.*

If Center Tank runs empty during flight:
> **CTR TANK TRANSFER** switch set to OPEN for at least one minute, then select SHUT

If nothing goes wrong, you should not have to touch the fuel subpanel again after engine start. If there is no fuel anymore in one of the tanks, however, you will have to use the crossfeed and common valves to fuel from one tank to all engines that need it.

SYSTEM DESCRIPTION

Fuel system overview

What is referred to as the fuel system is a mess of valves, pipes and pumps that move the fuel around to keep the engines and APU running when needed. The system is comprised of various common components that we have already come across in the hydraulics system. These common components are the fuel tanks that store the fuel, the fuel pumps that transfer the fuel to where it's needed and finally the fuel valves, which determine the way for the fuel.

On the following pages we will go deeper into the functioning and inner workings of this system. In a step-by-step rundown you will find out everything you need to know about the components and their function in the fuel system.

Fuel tanks

In total there are seven or nine fuel tanks, depending on the availability of auxiliary fuel tanks, and all of the tanks can be divided in several categories.

In the Ultimate BAe146 / Avro RJ Series, the auxiliary tanks are modeled, totaling an amount of nine fuel tanks. The tanks are as follows:

Main storage tanks:

1 Center tank

This is one of the main fuel tanks and is a fuel storage tank. The fuel in this tank is transferred to the left and right wing tanks.

2 Wing tanks

These tanks are the final two (one per wing) main storage tanks. The left and right wing tanks vent their fuel into the left and right inner feed tank, respectively.

Feed tanks

2 Inner feed tanks

These tanks "feed" the inner engines (engines 2 and 3) with fuel. Additionally the APU is fed by feed tank 2. These tanks also vent fuel into the left and right outer feed tank.

2 Outer feed tanks

These tanks feed the outer engines (engines 1 and 4) with fuel.

If required, feed tanks can also feed other engines than the ones they're assigned to.

Surge tanks

Two surge tanks in the wingtips provide an auxiliary storage capacity to receive an excess of fuel that might have spilled into the feed tanks. Fuel collected here is transferred back to the center fuel tank.

Auxiliary tanks

Two optional auxiliary tanks may be fitted so that the plane can carry more total fuel. Fuel in these tanks is transferred to the left and right main wing tanks.

Usable Tank Capacity		
Unit	lb	kg
Left Wing	8120	3683
Left auxiliary	1032	468
Center	4400	1996
Right Wing	8120	3683
Right auxiliary	1032	468
TOTAL	22704	10298
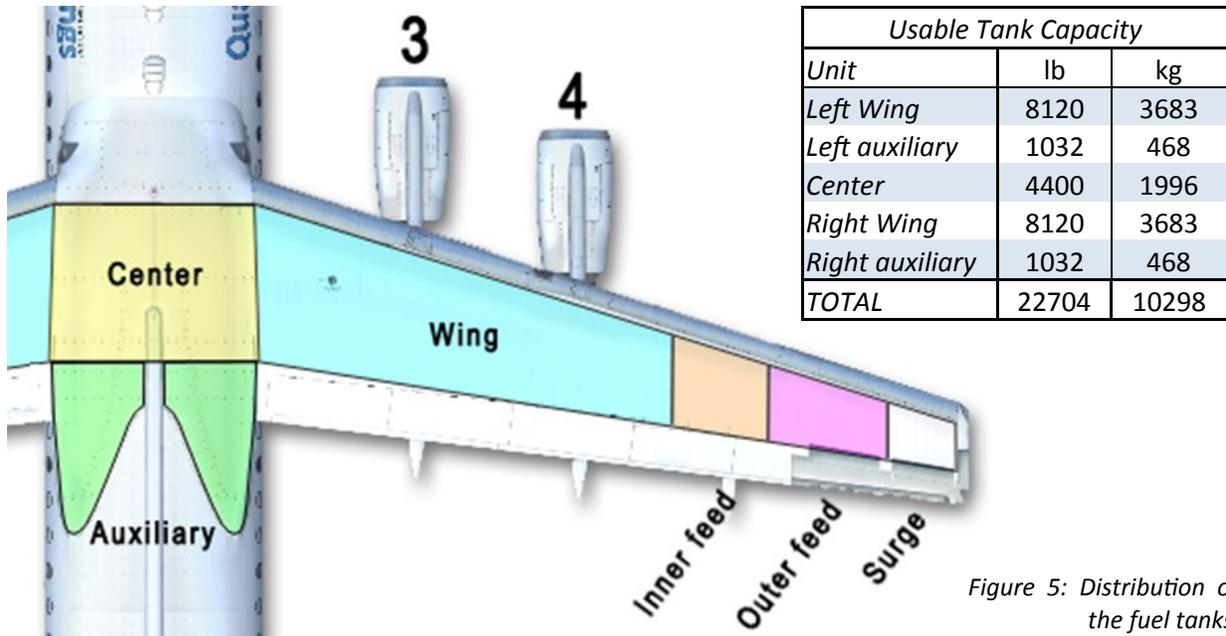
Figure 5: Distribution of the fuel tanks

Methods of inter-tank fuel transfer

So how is the fuel transferred from tank to tank? There are two methods for this:
By gravity
> Fuel is drawn down by gravity, and into the next fuel tank. This is effortless and efficient.

By the use of jet pumps
> The name is misleading for it, as it actually isn't a pump in the way we imagine. There are no moving parts and there is no motor to drive it. The principle is very simple and elegant however, and is pictured in Figure 6: use one "carrier" fluid to "carry" a "target" fluid from tank to tank. The carrier fluid, due to the speed it has already got prior to entering the jet pump, will "carry" the "target" fluid through the jet pump and into the next tank, almost acting like a bucket that is scooping up sand in one garden en depositing in a neighboring garden. However, in the jet pump, it is not sand that is being scooped around, but fuel from the inner feed tank. Because of this, it's not a problem that two fluids get mixed since they are and always have been exactly the same type of fluid: fuel.
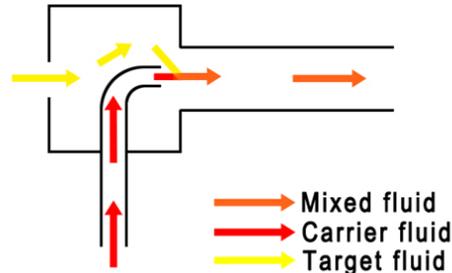
Figure 6: Jet pump schematic. The yellow "target" fluid is carried onwards by the red "carrier" fluid

You might wonder however where the "carrier" fluid is coming from. It was said just now that there are no moving parts, but if there is a strong current for the carrier fluid, then it must be driven by *something*. If not by gravity, then by what is the current generated? Indeed, by a pump! There are two pumps that facilitate the carrier fluid's strong current and thus its carrying capacity:

One pump is the inner feed tank's fuel pump. It doesn't pump all of its fuel to it respective engine. Instead, some amount is pumped back into the inner feed tank to act like the carrier fluid for the jet pumps.
One pump is driven by a hydraulic motor from the hydraulic system: this the standby pump of which there is one in each wing. It takes fuel from the inner feed tank and feeds that to the jet pumps where it acts as the carrier fluid.
Due to the existence of two pump mechanisms, the chances of inter-tank fuel transfer being stymied due to failures is lessened, more so due to the sufficient backup systems we already discussed in the yellow hydraulic system.

These methods of fuel transfer are used in inter-tank fuel transfer, not outside of it. Note that in Figure 8 no specific way of inter-tank fuel transfer is displayed, merely the direction of inter-tank fuel transfer by means of the black arrows. In the forthcoming explanation of the fuel tanks, however, it is mentioned what inter-tank fuel transfer method is used.

Inter-tank fuel transfer

As you can see in Figure 8, fuel is transferred from the center fuel tank to both wing tanks by use of jet pumps, while the auxiliary fuel tanks transfer fuel to either the left or right wing tank, depending on their position on the aircraft. This is done by a combination of gravity and jet pumps. Using the switch CTR TANK TRANSFER, you can control whether fuel from the center tank is transferred to the main wing tanks. Select OPEN to transfer, SHUT to stop transfer, and AUTO for automatic closure and opening of the center to wing tank transfer valves. The indication TRANSFER TO L/R TANK signifies that the valve on either the left or right side is open. Finally, on the main instrument panel, there are three fuel quantity indicators that show the amount of fuel still available in the left and right main wing tanks and the center tank (see also Figure 5). Note that for the auxiliary tanks there is no dial installed. Instead, there is only an annunciation light: L/R AUX TANK NOT EMPTY, to signify that that tank contains fuel.

Figure 7: the fuel quantity gauges on the main instrument panel

From the wing tank, the fuel is transferred to the left and right inner feed tanks by a combination of gravity and jet pumps. From here the fuel is then transferred either outside the fuel tanks (to which I'll come to later), or to the outer feed tanks (by gravity only). For each feed tank there is a dial that indicates the quantity of fuel still in that tank. If the fuel in the feed tanks reaches a low level , L/R FEED LO LEVEL annunciator will illuminate. Finally, there's also a fuel temperature indicator. The temperature indicated here is in fact the fuel temperature in the right outer feed tank.

From the feed tanks the fuel is in principle only transferred to the engines, but the addition of the surge tanks signifies that this is not the case: If an excess of fuel has been transferred to the feed tanks due to some event (thermal expansion, excess filling), fuel from the outer feed tanks "spill" over and is subsequently collected by the surge tanks. The surge tanks then transfer that fuel back to the center tank (not shown in Figure 8). Note that it is also for this reason that the legend says "Active fuel transfer within tanks" as clarification of the black arrow, for there might be fuel transfer between outer feed tank and surge tanks, but it's certainly not active!

Eventually, the fuel reaches the inner and outer feed tanks. What happens now? From here, the fuel is "fed" to the engines or APU. A fuel pump in each of the feed tanks pumps fuel into an array of pipes that eventually lead to either the engines or the APU. Figure 8 tries to picture this in an as simple way as possible. As you can see,

>   - The left outer feed tank feeds engine 1 with fuel via the red circuit;

>   - The left inner feed tank feeds engine 2 *or the APU or both* via the yellow circuit;

>   - The right inner feed tank feeds engine 3 via the green circuit;

>   - And the right outer feed tank feeds engine 4 via the blue circuit.

Note that these colors are completely arbitrary and are not referenced to in this way on the real plane. This system of colors was merely chosen for clarity. But let's not get ahead of ourselves. In these brightly colored pipes, the very first components we come across (besides the fuel tanks, which we already covered) are the fuel pumps.
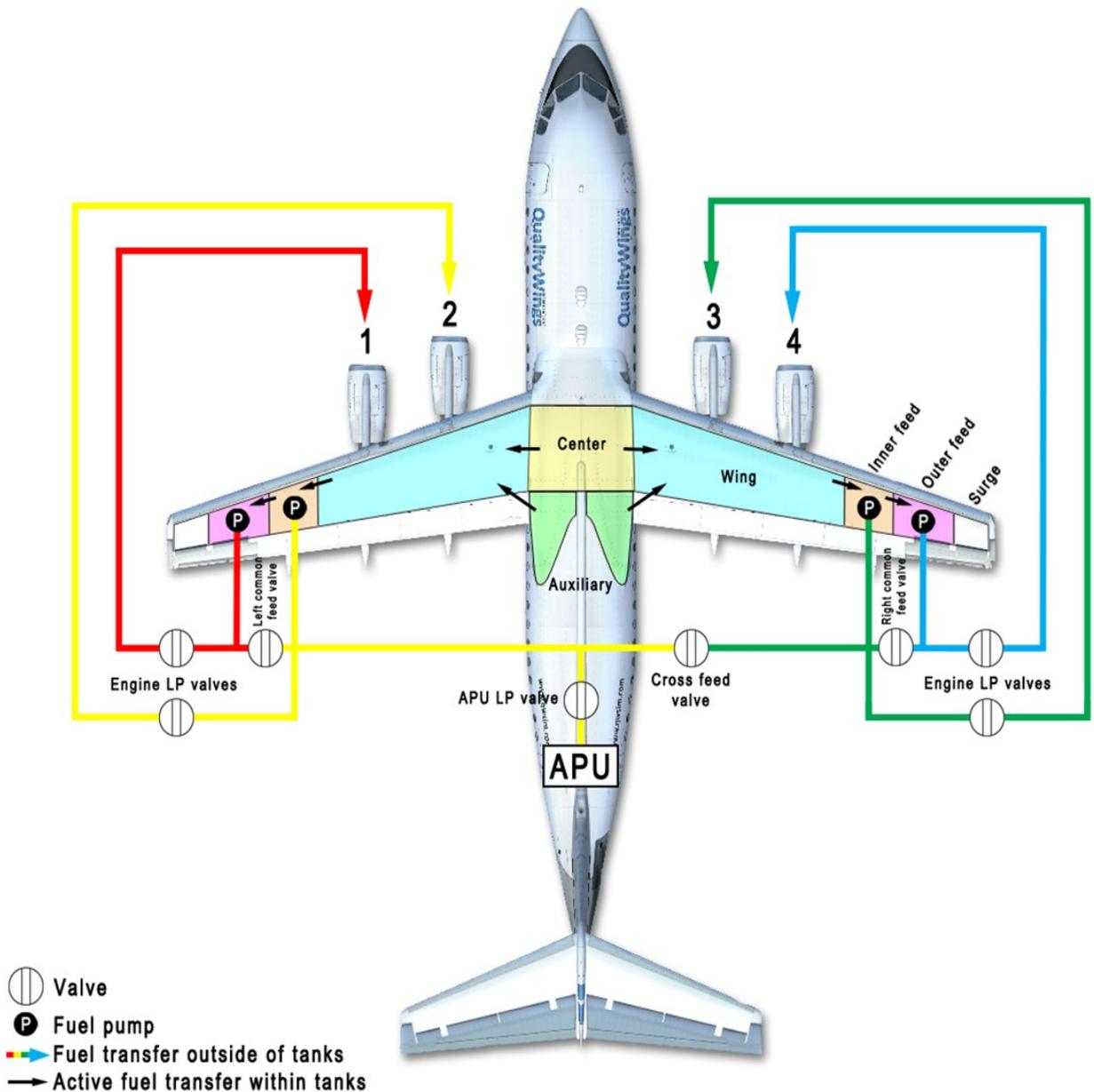
Figure 8: Schematic of the fuel system; fuel transfer inside and outside of the fuel tanks and the associated pumps and valves. Note that many details, such as jet pump placement, have been omitted in this figure for clarity's sake.

Fuel pumps

The fuel pumps transfer fuel out of the feed tanks and are, in principle, the driving force behind the "fuel feeding" system. While they pump, they also pressurize the fuel flowing around in the fuel feed system. There are four in total, one for each feed tank, and the AC buses electrically drive them. Please take a moment to review Figure 9, which displays the powering mechanism of the four fuel pumps. You will notice that for four fuel pumps, there are two AC power supplies:

The left outer and right inner feed tanks are driven by AC bus 1

The left inner and right outer feed tanks are driven by AC bus 2

This way, when one AC bus fails, the other AC bus can continue to provide power to at least one fuel pump on each wing. Why is this beneficial?
If an AC bus were to power all pumps on one wing, and the other AC bus all pumps on the other wing, consider what would happen if one pump fails, let's stay AC BUS 1, powering all left pumps. In this scenario, that would mean that on the left wing none of the pumps would operate, and on the right wing they would all operate. Since the left fuel pumps don't function, the fuel in the left wing tank remains unused, while the fuel in the right wing tank is used. As a result, the right wing will become ever more lighter while the left wing retains its weight. You can imagine that this will result in a major unbalancing act that will make it very hard to control the aircraft as time progresses. As such, having AC bus power left and right pumps and AC BUS power left and right pumps will mean that even in the event of a failure of one of the AC BUSses, all the fuel in all the tanks will still be used and no unbalancing act will occur, thus increasing safety on the plane in the event of a failure.
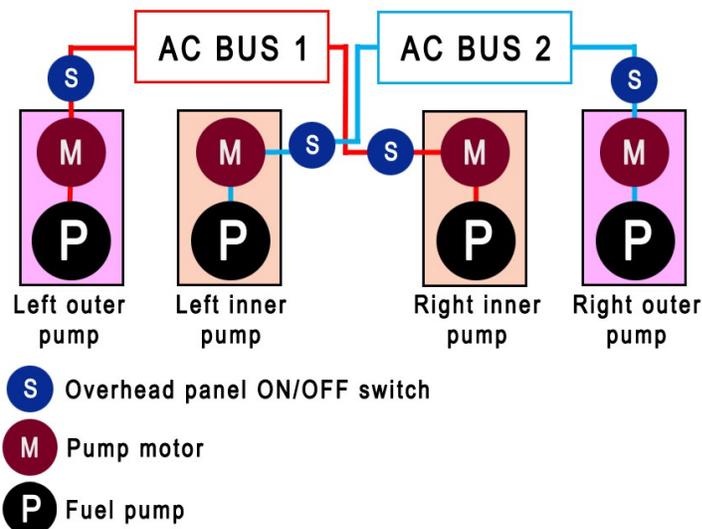
Figure 9: Fuel pump powering mechanism.

Secondly, you will notice that a switch may interrupt the power supply to a pump. These switches are the FUEL PUMP ON/OFF switches on the overhead. These switches enable the powering of the pump's motors to drive the fuel pump itself. In the event that the pump is turned ON but the pressure is low, a **LO PRESS** annunciation will light up on the overhead's FUEL subpanel.

Standby pumps

Besides the normal fuel pumps, there are two standby pumps, which have been mentioned earlier in the context of jet pumps. That's because the standby pumps do not pump fuel into the pipes that feed the engines and APU with fuel; the standby pumps merely pump fuel into the jet pumps to act as the "carrier" fluid, so that if the relevant inner feed tank fuel pump fails, the standby pump can take over its function, for otherwise inter-tank fuel transfer may be heftily compromised. The standby pumps are OFF by default, but can be manually switched ON via the STBY PUMP switches on the overhead's FUEL subpanel. The switch has two positions: ON and NORM. ON simply turns the pumps ON. At NORM, the pumps are OFF (NORM stands for NORMal, signifying a *normal* situation. In a normal situation, the standby pumps are not necessary and thus they do not run).

The standby pumps are pumps that are powered by hydraulic motors, connected to the yellow hydraulic system (see Figure 10 for the schematic). Operating the switches on the overhead panel open or close valves that enable or disable hydraulic fluid to reach the pump's hydraulic motor. DC BUS 1 and 2 power these valves. As long as power is provided, the valves remain closed, and no hydraulic fluid reached the pump's hydraulic motor. If DC BUS 1 or 2 fail, however, power to the valves is lost and they automatically open because of this (power is needed to let them remain closed, while no power is needed for them to be open). As a result, at the event of catastrophically electrical failures, the hydraulic standby pumps will automatically run regardless of the switch positions in the cockpit. Do note that if AC BUS 1 or 2 are lost but DC BUS 1 or 2 are still running, the pumps have to be activated manually using the STBY PUMP switches on the overhead's FUEL subpanel.
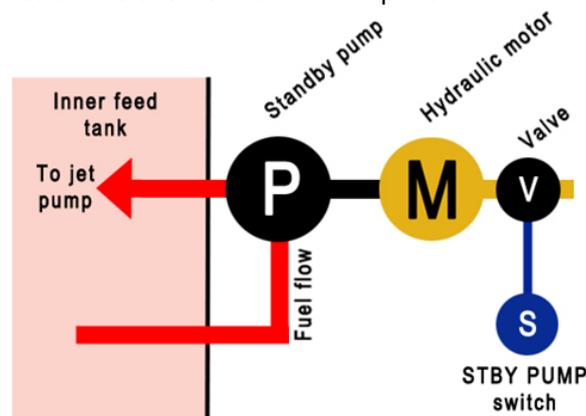
Figure 10: schematic of a standby pump. Via the STBY PUMP switch on the overhead, the valve is operated. When the valve is opened, hydraulic fluid reaches the hydraulic motor, causing it to run and thus operating the standby pump. The standby pump takes fuel from the inner feed tank and pumps it to the jet pumps.

For each standby pump, there is low pressure annunciation light: STBY LO PRESS. It illuminates if low pressure is detected at the pumps, signifying a pump failure, but only if the pump was supposed to be running. So this would be the case if the STBY PUMP switches were set to ON, for example.

Valves

Before the fuel can actually reach the engine or APU, it must pass one or more valves.
There are several valves in the fuel system termed cross, common and low pressure (LP) valves.
These valves and their positions can be reviewed in Figure 8.

The cross feed (X-FEED) valve is a valve that allows fuel to flow from the left wing feed tanks to the right wing engines or from the right wing feed tanks to the left wing engines. There is a switch on the overhead panel to SHUT or OPEN the cross feed valve. An annunciation light comes ON when the valve is not in the position commanded by the switch. Note that it will also light up when the valve is in transfer to the commanded position. A white FUEL FEED OPEN annunciation on the CSP will come on if the cross feed valve is open.

The common feed valves are like the cross feed valve, except that there are two of them and they are positioned between the inner and outer feed tanks. They allow fuel to be pumped from the outer feed tank to the inner engine or from the inner feed tank to the outer engine. Switches on the overhead panel enable the crew to SHUT or OPEN them, and an annunciation light comes ON when the valve is not in the commanded position. Note that it will also light up when the valve is in transfer to the commanded position. A white FUEL FEED OPEN annunciation on the CSP will come on if either one of the common feed valves are open.

Now consider the combined function of the cross and common feed valves using Figure 8, Figure 10 and Figure 11 as a guide. To do this, let us also go back to a failure scenario in which *AC BUS 1* fails. This means that:

> *The left outer fuel pump isn't powered => engine 1 doesn't receive fuel*

> *The right inner fuel pump isn't powered => engine 3 doesn't receive fuel*

At this point engines 1 and 3 will stop working if we don't restart the fuel flow to the engines. We do this by opening the *common feed valves* as shown in Figure 11. By opening them we:

> *Allow fuel to travel from the left inner fuel pump to not only the left inner engine, but also to the left outer engine, thus providing it with fuel.*

> *Allow fuel to travel from the right outer fuel pump to not only the right outer engine, but also to the right inner engine, thus providing it with fuel.*
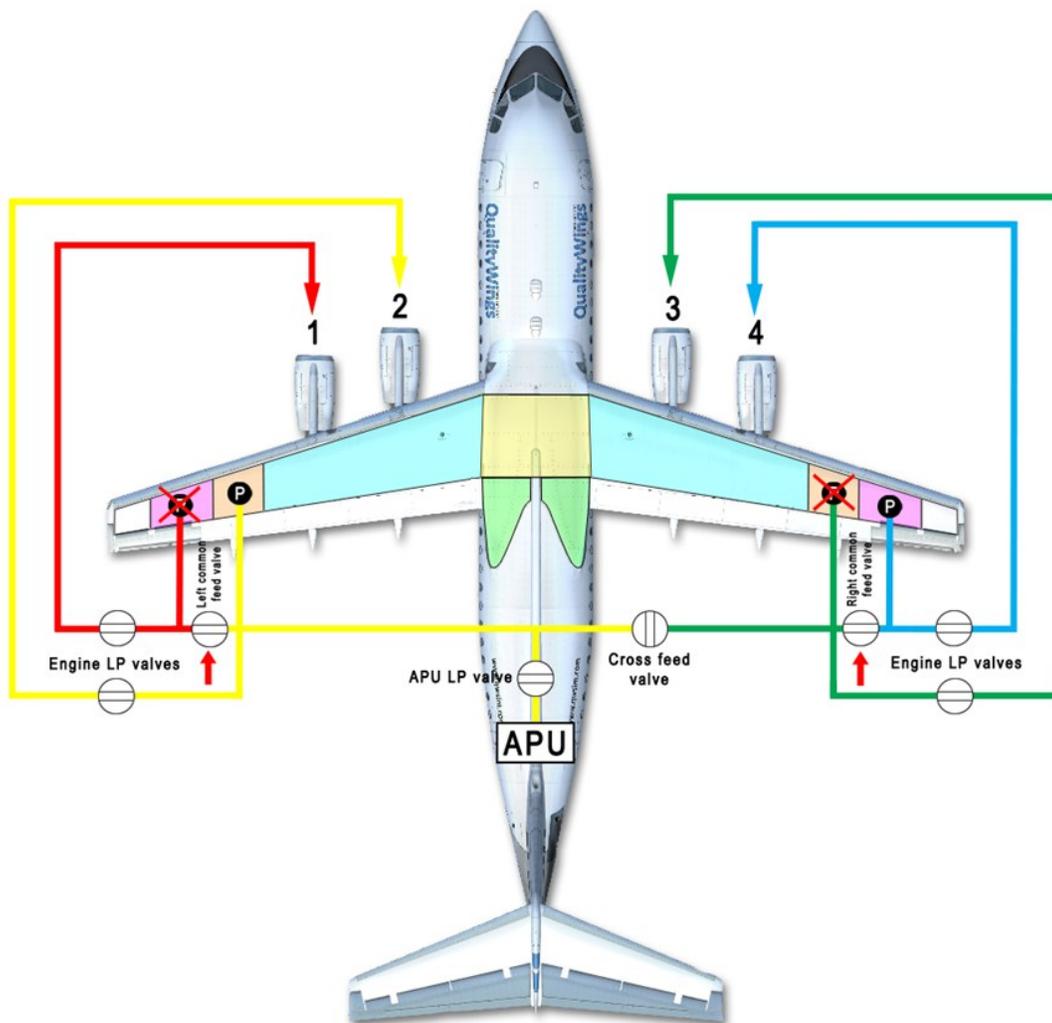
Figure 11: Valve positioning in the event of AC BUS 1 failure, resulting in the failure of several pumps (crossed out pumps). This results in interrupted fuel flow to engines 1 and 3. Fuel flow to the engines can be resumed however by opening the two common feed valves (red arrows).

What about the **cross feed valve**?

Consider a similar failure scenario: *AC BUS 1* has failed, but also the *left inner pump*.

This means that left outer, left inner and right inner pumps all fail to pump fuel and their respective engines are not provided with fuel. How do we solve this problem?

We do so by not only opening the *common feed valves*, but also the *cross feed valve*. This way, fuel is allowed to travel from the right outer pump to all four engines. You can check this is true by reviewing Figure 12.

Please note that operation of these valves is not strictly limited to failure scenarios or emergency events.

For example, in the event of low fuel, or empty fuel tanks, operation of these valves might be necessary. Both the common and cross valves are powered by essential DC power, meaning that in the event of electrical failures, the valves will still be operable via emergency DC power. In the event of complete power loss, the valves will stay in their last commanded position.
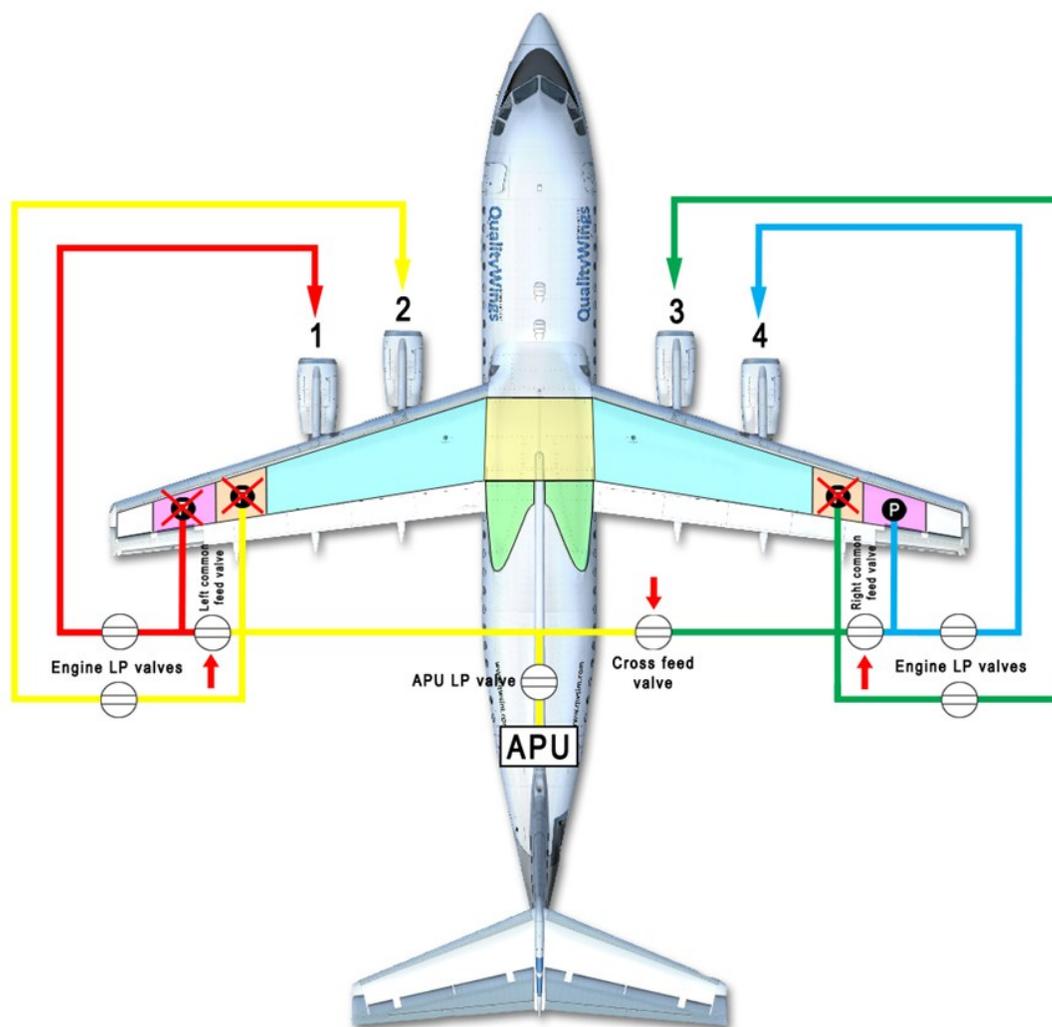
Figure 12: Valve positioning in the event of AC BUS 1 and left inner pump failure, resulting in the failure of several pumps (crossed out pumps). As a result engines 1, 2 and 3 will not receive fuel. To resume fuel feeding to these engines, the common feed and cross feed valves have to be set to OPEN (red arrows).

The last set of valves is the **Low-Pressure or LP valves**.
You might have noticed that their position is such that if closed, they shut the passage to either the engines or APU. This is because their single purpose is to cut off fuel flow to the engines in case of emergency or stop fuel flow to the APU when it is turned OFF.
Please beware though: the engine's LP valves cannot be opened or closed at will. Contrary to what you might think, they are not controlled by placing the throttle levers in the FUEL OFF or FUEL ON detents, or, on Boeing aircraft, the RUN and CUT positions of the fuel flow switches on the throttle quadrant. No, the LP valves are actually controlled by the fire handles, on the overhead. In case of an engine fire, you'll want to restrict fuel flow to that engine and cut it out of the fuel system due to explosion danger. By pulling on an engine's fire handle, the LP valve will automatically close, thus isolating it from the fuel feeding system. Note that the engine's LP valves are not simulated, since operation of the fire handles also isn't simulated.
A fire handle doesn't govern the APU's LP valve, however. The APU START/STOP switch controls this LP valve. When you START the APU, the valve will open, thus allowing fuel to reach the APU, and the valve will close once the APU is stopped.

If there is a problem with fuel feeding to the engines, there are amber **FUEL LO PRESS** annunciators on the CWP for each engine. This usually means that no fuel is reaching that engine, and this kind of annunciations can light up in, for example, the failure scenarios we discussed earlier.
Note that as such, this is a very different indication than the **LO PRESS** annunciation you might also see. The **LO PRESS** annunciation signals a *malfunctioning pump*, while the **FUEL LO PRESS** indicates a low fuel pressure at the *engine fuel inlet*.

System summary

The fuel system is comprised of some basic components: fuel tanks, which store fuel, fuel pumps, which pump fuel towards the engines or APU, and fuel valves, which close or open fuel lines to the engines.

There are six different types of fuel tanks: the main center tank is a storage tank that has a large fuel storage capacity. The auxiliary tanks are smaller storage tanks placed aft of the main center tank. The two wing tanks are big storage tanks placed on the wings, one on each wing. There are four fuel feed tanks, defined as two inner and two outer feed tanks. These are also placed on the wings. Finally, there are two surge tanks. If under the influence of excessive G-forces or turbulence an excessive amount of fuel enters the feed tanks, this fuel can be leaked into the surge tanks to avoid too high fuel pressure inside the fuel feed tanks.

The four fuel pumps, one in each feed tank, pump fuel to the engines via the fuel lines. In principle each fuel pump supplies one engine, but by opening or closing the various fuel valves, it is possible to open or close access to other engines as well. This would be useful in case of fuel pump failure: the engine which has lost its fuel pump can then be supplied by another engine's fuel pump.

ELECTRICS

TR1 ammeter
> *Gauge showing the busbar load on transformer rectifier 1 (TR1)*

TR2 ammeter
> *Gauge showing the busbar load on transformer rectifier 2 (TR2)*

BATT ammeter
> *Gauge showing the load on the battery (BATT)*

DC voltmeter
> *Gauge showing the DC voltage of the source selected with the DC rotary knob*

DC power source rotary selector
> *Rotary knob allowing you to select the source you want to see on the DC voltmeter*

AC voltmeter
> *Gauge showing the AC voltage of the source selected with the AC rotary selector*

AC power source rotary selector
> *Rotary knob allowing you to select the source you want to see on the AC voltmeter*

AC frequency meter
> *Gauge allowing you to see the frequency of the source selected with the AC rotary selector*

BATT 1 HI TEMP
> *Annunciation light indicating that BATTery 1 has a too high temperature (57° or higher)*

EXT AC PWR AVAILABLE
> *Annunciation light indicating that EXTernal AC PoWeR is available. External AC power is delivered by the Ground Power Unit (GPU)*

BATT NO CHARGE
> *Annunciation light indicating that the BATTery is not being charged*

STBY GEN ON
> *Annunciation light indicating that the STandBY GENerator is ON and delivering power*

DC BUS 1 OFF
> *Annunciation light indicating that DC BUSbar 1 is not powered*

EMERG DC OFF
> *Annunciation light indicating that the EMERGency AC busbar is not powered*

ESS DC OFF
> *Annunciation light indicating that the ESSential DC busbar is not powered*

DC BUS 2 OFF

Annunciation light indicating that DC BUSbar 2 is not powered

AC BUS 1 OFF

Annunciation light indicating that AC BUSbar 1 is not powered

ESS AC OFF

Annunciation light indicating that the ESSential AC busbar is not powered

EMERG AC OFF

Annunciation light indicating that the EMERGency AC busbar is not powered

AC BUS 2 OFF

Annunciation light indicating that AC busbar 2 is not powered

EXT AC ON/OFF switch

Switch allowing you to connect the aircraft's electrical system to the external AC source (GPU). Hold ON momentarily to do so. Select OFF to disconnect from the GPU

BUS-TIE switches (not simulated, defaults to AUTO)

Switches allowing you to either have both AC and DC tie breakers operate normally, or you can select either AC, DC or both to OPEN and thus have the AC1, AC2 and/or DC1, DC2 channels be disconnected from the aircraft's electrical system

STBY INV switch

Switch allowing you to turn the STandBY INVerter OFF, ARM it so that it starts delivering EMERGency AC power if ESSential AC power is lost, or set it to OverRIDE so that it will supply EMERGency AC power regardless of the state of ESSential AC power sources

STBY GEN switch

Switch allowing you to turn the STandBY OFF so that it does not deliver power, ARM it so that it automatically runs when both AC busbars are lost, or set it to OverRIDE so that it delivers power regardless of the state of both ESSential busbars

Generator 1 ammeter

Gauge showing the load on GENerator 1

APU generator ammeter

Gauge showing the load on the APU generator

Generator 4 ammeter

Gauge showing the load on GENerator 4

DRIVE 1 HI TEMP

Annunciation light indicating high oil temperature for generator 1

APU DRIVE FAIL

Annunciation light indicating that the oil temperature in the APU generator is low

DRIVE 4 HI TEMP

Annunciation light indicating high oil temperature for generator 4

GEN 1 OFF LINE

Annunciation light indicating that generator 1 is disconnected from the system, but not necessarily de-energized

APU GEN OFF LINE

Annunciation light indicating that generator 1 is disconnected from the system, but not necessarily de-energized

GEN 4 OFF LINE

Annunciation light indicating that the APU generator is disconnected from the system, but not necessarily de-energized

GEN 1 switch

> *If there are no faults, this switch allows you to turn GENerator 1 ON, at which point the generator is energized and connected to the rest of the system so that it delivers power, set it OFF LINE, which energizes generator 1 but disconnects it from the rest of the system, or set it to OFF/RESET, which de-energizes generator 1 and disconnects it from the rest of the system*

GALLEY/SHED switch

> *Allows you to turn ON or OFF power to the galleys*

APU GEN switch

> *If there are no faults, this switch allows you to turn he APU GENerator ON, at which point the generator is energized and connected to the rest of the system so that it delivers power, set it OFF LINE, which energizes the generator but disconnects it from the rest of the system, or set it to OFF/RESET, which de-energizes he generator and disconnects it from the rest of the system*

GEN 4 switch

> *If there are no faults, this switch allows you to turn GENerator 4 ON, at which point the generator is energized and connected to the rest of the system so that it delivers power, set it OFF LINE, which energizes generator 4 but disconnects it from the rest of the system, or set it to OFF/RESET, which de-energizes generator 4 and disconnects it from the rest of the system.*

HOW TO USE

Like many of the systems accessible via the overhead panel, also the electrical system is a set-and-forget kind of system. Still, the electrical system is the most difficult system on this plane, and unlike many of the other systems, you will have to have at least a fairly basic understanding of how it operates. What follows in this subchapter is a brief overview of when to use what power sources and why, and how to setup the electrics subpanel on the overhead panel during the various phases of flight.

On the ground – flight deck safety checklist

Set the BATT switch to ON

> *This will provide the aircraft with battery power. Use the voltage gauge rotary selector to check battery voltage: should be minimum 23V*

Set the STBY INV switch to ARM

> *In case of emergency and critical power loss, this will make sure that the standby inverter will automatically engage*

Set the STBY GEN switch to ARM

> *In case of emergency and critical power loss, this will make sure that the standby generator will automatically engage*

Set the GEN 1 and GEN 4 switches to OFF/RESET

> *Because the battery will not hold out forever and powers only 60% of the aircraft functions, you must either use the APU or an external AC source (Ground Power Unit, GPU)*

> ***-For the APU generator**, set the APU GEN switch to ON*
> > *NOTE: The APU has to be running. How to start the APU can be found on page 76*
> ***-For external AC (GPU)**, set the EXT AC switch to ON.*
> > *Make sure that the EXT AC AVAILABLE annunciator is lit; If the annunciator light is not illuminated, connect the GPU using the QW Control Panel first!*

On the ground – before start

It is normal procedure to start the engines during pushback. As such, you have to make sure that…

You are on APU GEN, not EXT AC

If on EXT AC, start the APU and set the APU GEN switch to ON once APU PWR is available. How to start the APU can be found on page 76.

The GPU is disconnected

If you are on EXT AC, disconnect from it now by setting the EXT AC switch to OFF. Do make sure that before you do so, the APU GEN is supplying power. You can always check this by looking at the APU GEN voltage meter and ammeter

On the ground – after start

After engine start you will have to look one more time at the electrics subpanel:

set the GEN 1 and GEN 4 switches to ON

This will connect the two engine-driven electrical generators to the aircraft electrical system. As a result, the APU generator will be disconnected. Because the APU is now disconnected from the aircraft's electrical system, you can set the APU GEN switch to OFF/RESET and turn off the APU. That is, if the APU is not currently powering any other systems, such as the air conditioning!

At this point make sure that all annunciators on the electrical system subpanel are OFF.

In flight

During the flight you will not have to worry about the electrical subpanel.

After landing

Directly after landing, while taxiing and at the gate there are various things for you to do:

Start the APU

Do this while taxiing to the gate, as this will give the APU the time it needs to spool up. You can then use the APU GEN to supply power when you shut down the engines once arrived at the gate.

Once the APU generator supplies power (check the APU GEN volt- and ammeter)

Set the APU GEN switch to ON. Now set the GEN 1 and GEN 4 switches to OFF/RESET

Shutdown

If you intend to **park your plane** and leave it for some time, you may shut it down completely.
To do so, put the APU switch to the STOP position and set the APU GEN switch to OFF/RESET.
Then set the BATT switch to OFF. You have now powered down the entire aircraft.

Note that if you intend to just drop off passengers and take on board a new load, you might as well leave the aircraft powered using the APU generator or external AC.

SYSTEM DESCRIPTION

Electrical System Introduction

The electrical system is without a doubt the most complicated system on the Avro RJ series of aircraft. It consists of many different components that interact with each other, supplying each other with power and allowing the aircraft to operate normally. During your flight, you will probably hardly do anything with the electrical system, and that's a good thing: it is a rather hidden system in that you can ignore it most of the time, as long as you set up everything correctly to begin with. As such, if you are not interested in the electrical system's inner workings, you can skip most of this chapter. The main components of the electrical system are:

Power sources

> The power sources are the core of the electrical system, they supply the plane with power. A power source can be an engine generator (termed generator 1 and 4 because they are driven by engines 1 and 4, respectively), the APU generator, the battery, an external AC source (the Ground Power Unit (GPU)) or the standby generator.

Contactors

> Very straightforward: contactors are switches. It's like flicking a lamp's switch in your house. When you click the switch, the lamp turns on because a contactor closed. As such, a contactor closes a circuit or breaks a circuit.

Busbars

> Busbars are numerous in the electrical system. Think of them as a sort of multiple socket: instead of drawing multiple wires from the generator to everything that needs power, you connect everything to one busbar, and then connect that to the generator. Once a busbar is powered, its respective annunciator light extinguishes on the overhead panel. See Figure 13 for a simple overview of busbar use.

Busbars are probably one of the most important components of the electrical system and they represent power *sinks*: objects that use power instead of producing them. In that sense they are antagonists of the power sources. Keep one thing in mind while you read this chapter concerning busbars: busbars equal various types of equipment. Losing a busbar, means losing equipment of all kinds. The EADI and EHSI might, for example, stop operating with the loss of one or more busbars. The entire goal of the electrical system is therefore to supply the busbars with power.
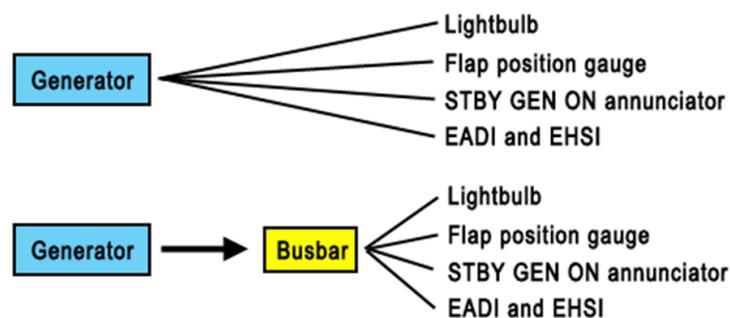
Figure 13: The use of the busbar. Instead of connecting all power consumers separately to the generator, you connect everything to the busbar. You then connect the busbar to the generator.

All these components are organized into two channels.
Channel 1 consists of generator 1 and all components listed as "1" (e.g. AC BUS 1, DC BUS 1, etcetera).
Channel 2 consists of generator 2 and all components listed as "2" (e.g. AC BUS 2, DC BUS 2, etcetera).
The only two components that do not belong in any of the two channels are the APU generator and the external AC.

There are two kinds of power that are generated: AC power and DC power.
Most of the power sources listed above supply AC power. Only the battery supplies DC power. AC and DC power can be converted into each other. AC power can be converted into DC power by a Transformer Rectifier (TR). DC power is converted into AC power by a standby inverter. This happens automatically and the pilot does not interfere.

As such we see a split into four parts in the electrical system of the Avro RJ. The first one is one into two channels, the second one into AC and DC power. At all times, at least a quarter of this system will operate. If all AC power sources fail, the battery will take over, a DC power source. If channel 1 fails, channel 2 will always be available and vice versa. This way redundancy is built in, an absolutely essential feature for aircraft systems.

Power sources

The plane has a variety of power sources that are used at various stages of the flight. The various power sources are the following ones:

Engine generators

> The plane has two generators, which are driven by the engines. The generators are generator 1 and 4, so called because they are driven by engines 1 and 4 respectively. These are always the preferred power sources and you turn these on once engines 1 and 4 are running. They can supply the entire aircraft with power. They are used during most of the flight, from the moment the engines have been started until they have been shut down.

APU generator:

> The APU generator is driven by the APU, can supply power to the entire plane and is mainly used when the engines are shut down. The APU generator is an auxiliary power source and always takes preference over the external AC.

External AC (GPU)

> The external AC is provided by a Ground Power Unit, and as such it's not really an aircraft's power source. It can provide the entire aircraft with power, however. The external AC is used when the engines are not running and thus the engine generators can't provide power, and when the APU is not running (to preserver fuel for example). The external AC is a auxiliary power source. The APU is preferred over the external AC.

Standby generator

> A generator powered by a hydraulic motor. The hydraulic motor is powered by the green hydraulic system. The standby generator is an emergency generator that can be used to power the most vital parts of the plane in a case of emergency. It is therefore usually only used in emergencies. Note that because it needs green hydraulic power, you must have a running engine number 3, or the hydraulic motor for the standby generator will not operate.

Contactors

Contactors are, as was said previously, simple "switches". It will break or close a circuit. Contactors can be manual and automatic, and they can be interlocked. Manual contactors are opened and closed by setting switches in the cockpit. Automatic ones will open or close without crew intervention. Interlocked contactors are two contactors joined together: they allow only one circuit to be closed at a time. Figure 15 shows the three possible positions of an interlocked contactor, being either open, or either one of the two circuits closed.
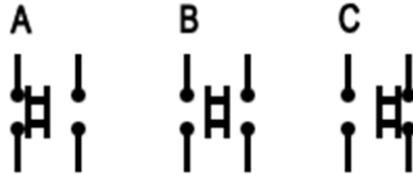
Figure 15: Interlocked contactor. The three possible positions of an interlocked contactor are shown. A left circuit closed; B both circuits open; C right circuit closed.

Busbars

There is a large amount of busbars in the electrical system of the Avro RJ. These busbars are categorized according to what aircraft systems/parts they supply power.

Emergency busbars (EMERG AC/DC)
> These busbars provide the most vital systems with power. These parts are the most essential during an emergency. Think of systems like the altimeter, DBI and fuel quantity indicators.

Essential busbars (ESS AC/DC)
> These provide essential aircraft systems with power. Essential systems are system that are very important, but are not absolutely vital during an emergency. Think of systems and gauges like the attitude indicator, taxi lights and the transponder, which are not vital to flying the plane.

The start busbar
> The start busbar provides start power for APU and engine start.

Main busbars (AC1/AC2/DC1/DC2)
> These busbars power much of the rest of the aircraft's various systems. Think of the various fans, the spoiler indicator and autopilot. While important, these systems are not essential or vital during emergencies.

Battery busbar
> The battery busbar hardly powers anything, instead relying on the emergency AC and DC bus bars to power the most vital instruments.

The names given to the various busbars (main – essential – emergency) signify a core principle in the electrical system of the Avro RJ: one of power levels.

Introduction to power levels

A power level is an amount of power available to the aircraft. This is not necessarily a specific voltage or current, but an availability of power sources. The power level will drop, for example, if both engine generators fail to provide power. However, contrary to what you might think, the essential thing here is not so much the power source, but the busbar: whether a bus bar is powered or not, is what defines the current power level. Note that there is no "power level meter". This is a fictional thing, but it helps in understanding how the electrical system is organized. See Figure 16.
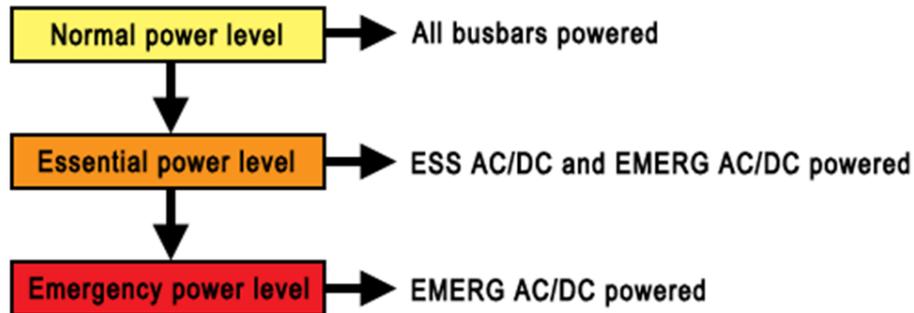
Figure 16: The relation between power levels and what busbars are powered.

When all busbars are powered we have a normal situation. At this point everything receives the power it needs to operate normally. When generators 1 and 4 fail, however, the power level drops to Essential power level. The standby generator takes over what it can, which means that the main busbars are now no longer powered. Only the essential and emergency busbars are powered, which is why it is called "essential power level": there is enough power to not only power the emergency busbars, but also the *essential* busbars. When also the standby generator fails, however, the essential AC busbar is lost as well; the essential DC busbar may still be powered. For the rest, only the *emergency* busbars are powered: we have dropped to emergency power level.

This is the core principle behind the entire electrical system, and everything operates according to this very simple schematic. But what is the goal of this principle? It creates a "safeguard" mechanism, a sort of "safety net" where, if an upper level fails, there is lower level that can "catch" at least some of the functions of the failed level. As such, you should see the emergency power level as the base system, and every power level on top of it as an extension to that base system.

We will now go on to look at much more detailed schematics of the electrical system of the Avro RJ. Try to remember the schematic in Figure 43 for the remainder of this chapter.

The big picture
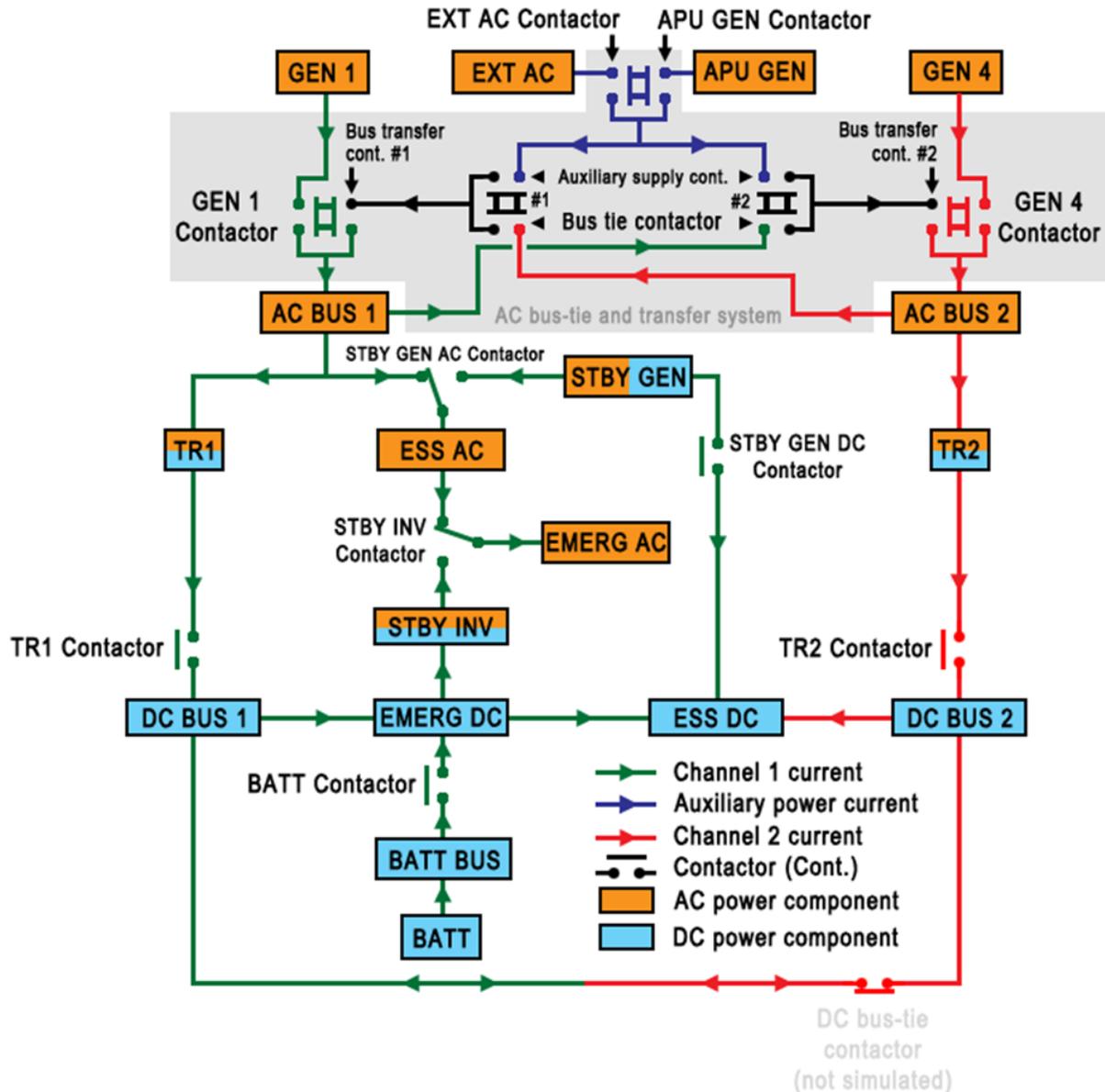
Figure 17: Schematic of the electrical system: the big picture.

The schematic in Figure 17 will seem overwhelming and will probably be very hard to understand at first. It's important to recognize two things: first of all remember that the circuit is aimed to get power from one or more power sources to all busbars, secondly that within this schematic there are four distinct "layers":

>   - The AC bus-tie and transfer system, shown within the grey area

>   - Components active at a normal power level (all busbars)

>   - Components active at an essential power level (ESS AC, ESS DC, EMERG AC, EMERG DC)

>   - Components active at an emergency power level (ESS DC, EMERG AC, EMERG DC)

The base layer is then synonymous to the emergency power level, and every layer on top of it is an extension to the base layer.

We will discuss the various layers from above (the full system) to below (the base system). While possibly counterintuitive, we do this so that it will be clear how every layer is built on top of the base system.

—INTENTIONALLY LEFT BLANK—

The AC bus-tie and transfer system
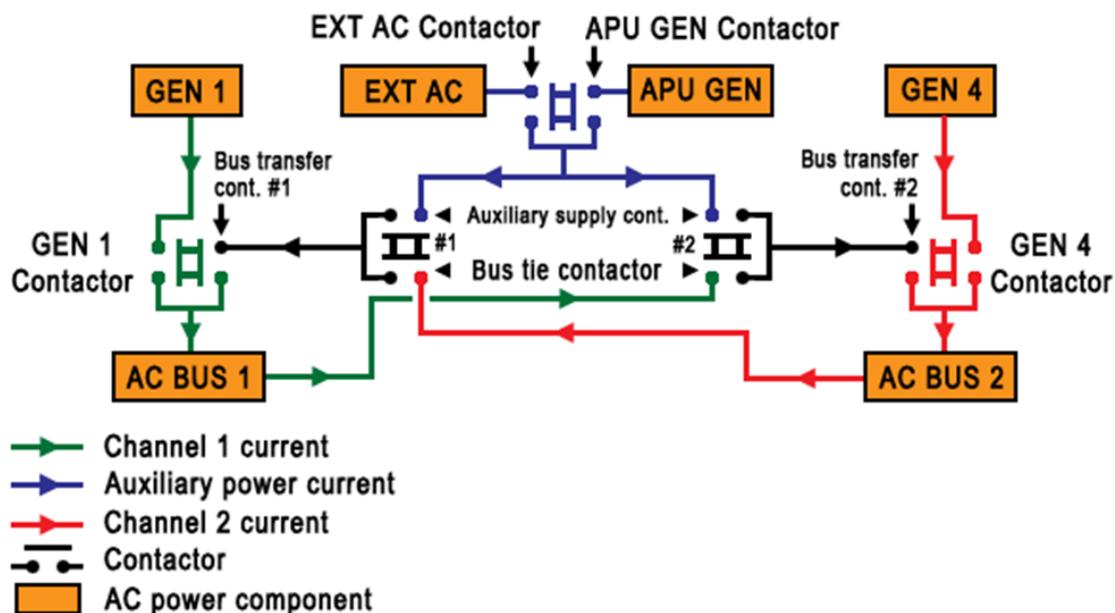
Figure 18: The AC bus-tie and transfer system.

Figure 18 shows an adjusted view of Figure 17. Everything has been removed, except for the parts relevant to the bus-tie and transfer system.

What you see here is a circuit that serves one function: make sure that AC BUS 1 and 2 are powered. They are always powered by at least one of the four sources: GEN1, GEN4, EXT AC or the APU GEN, all seen in Figure 18. The complex part is how power to the AC BUS 1 and 2 is eventually established. For this, a series of interlocked contactors - their operation was explained previously - have been put into place. Most interlocked contactors can be manually closed or opened, but some are automatic. Now follows a list of the contactors describing their function and if they are manually closeable:

The GEN 1 contactor can be closed by setting the GEN 1 switch to ON. It allows the crew to power to AC BUS 1 using GEN 1.

The GEN 4 contactor can be closed by setting the GEN 4 switch to ON. It allows the crew to power to AC BUS 2 using GEN 4.

The EXT AC contactor can be closed by setting the EXT AC switch to ON. It allows the crew to power both AC buses using external AC (the GPU).

The APU GEN contactor can be closed by setting the APU GEN switch to ON. It allows the crew to power both AC buses using the APU generator.

The bus –tie contactors can be closed by setting the AC bus-tie switch to AUTO. The crew can use these contactors to have one AC BUS power the other AC BUS.

The two bus transfer contactors are automatic, but are influenced by the GEN 1 and GEN 4 switches. They allow a power source other than the main generators to power the AC buses.

Which contactor is eventually closed, depends on the power source use you want to use, and even then, there is internal logic in place that determines which power source of the ones that are activated, will be used. In this explanation, we will call this the "preferred power source logic".

Preferred power source logic

Depending on the power source you want to use, different contactors will close if their switches have been set correctly. "Correctly" means setting their switches to ON or AUTO. The logic of the electrical system will determine if the contactor should indeed close.
This logic is actually rather straightforward:

-If only one power source has been activated, select that power source.

-If APU GEN and EXT AC have both been selected to ON, APU GEN will always be preferred.

-If EXT AC and/or APU GEN have been activated, but also GEN 1 and/or GEN 4, then the main

 generators will always be preferred.

One can summarize this logic as follows:
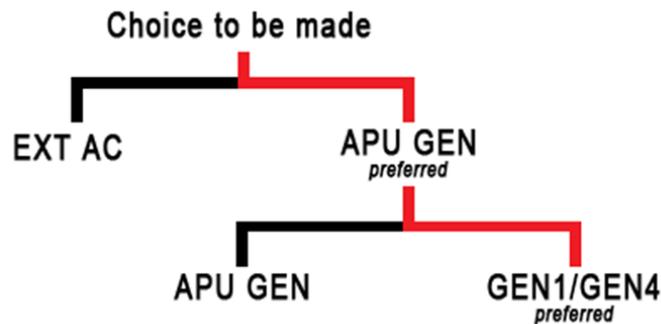
Figure 19: Preferred power source logic of the electrical system: which power source to use when multiple are available to power the main AC buses. The red line shows the preferred route.

Following the diagram in Figure 19, we will explore all the settings of the contactors in the AC bus-tie and transfer system in accordance with the various power sources used.
Before we do so however, it's important to learn about a limitation in this circuit:

The current can only flow into one direction!

Because of this limitation, the circuit is a bit more complicated than it otherwise would have been, and the way this limitation is expressed within the circuit, is by the addition of the bus-tie contactors. The bus-tie contactors allow one AC BUS to supply power to the other AC BUS. So, AC BUS 1 can supply power to AC BUS 2 and vice versa. The crew will want to do this in the event of a failure of one of the main generators, being GEN 1 or GEN 4.
Here's also where the AC bus-tie switch comes into play. This switch has two positions: AUTO and OPEN.
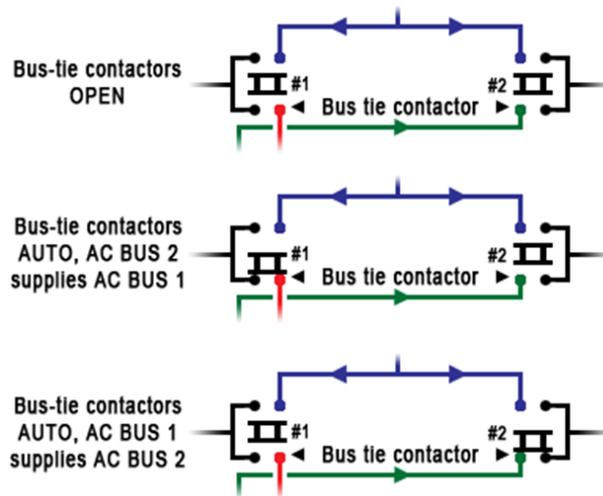
Figure 20: Schematic of the bus-tie contactors showing the various positions they can be in.

Figure 20 Gives a good visual overview. The figure shows the various functional positions of the two bus-tie contactors and alongside which AC BUS powers what AC BUS.
As you can see…

- at OPEN (not simulated), the bus-tie contactor will always be open, no matter what.

- at AUTO, the bus-tie contactors will close automatically if need be. So, a bus-tie contactor will close if an AC BUS is not powered. If AC BUS 1 is not powered, bus-tie contactor 1 will close, and if AC BUS 2 is not powered, bus-tie contactor 2 will close.

Just keep in mind that the bus-tie contactors will only close if one of the main generators has failed and either one of the AC busses ends up unpowered. In any other case, the bus-tie contactors will default to OPEN. With that cleared up, we will look at the various scenarios of the ac bus-tie and transfer system. As previously said, we will follow the logic depicted in Figure 19.

EXT AC in use
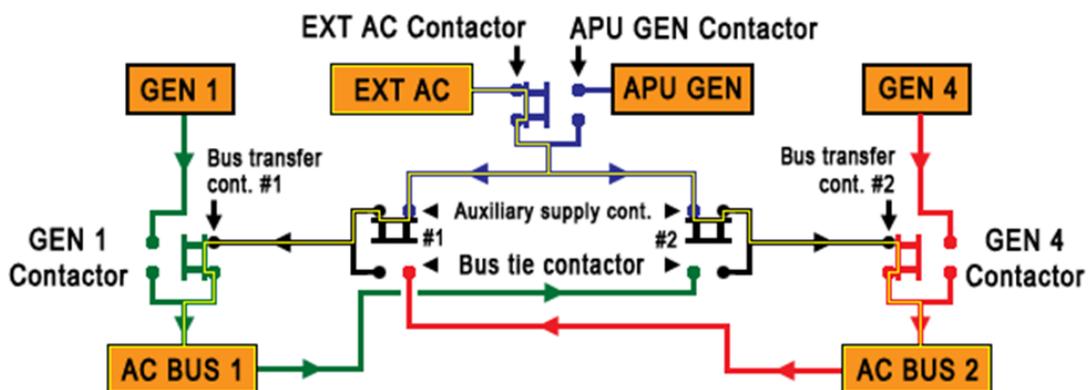
Figure 21: AC bus-tie and transfer system with EXT AC as the active power source

The less preferred option in the preferred power source logic is the external AC (GPU). You can get EXT AC to power both AC buses by connecting EXT AC to the aircraft and setting the EXT AC switch to ON when the EXT AC PWR AVAILABLE annunciator light illuminates on the overhead panel. In that event the EXT AC contactor will close, and so will the auxiliary supply and bus transfer contactors. Both AC busses will now be powered, as Figure 21 shows also.

APU GEN in use
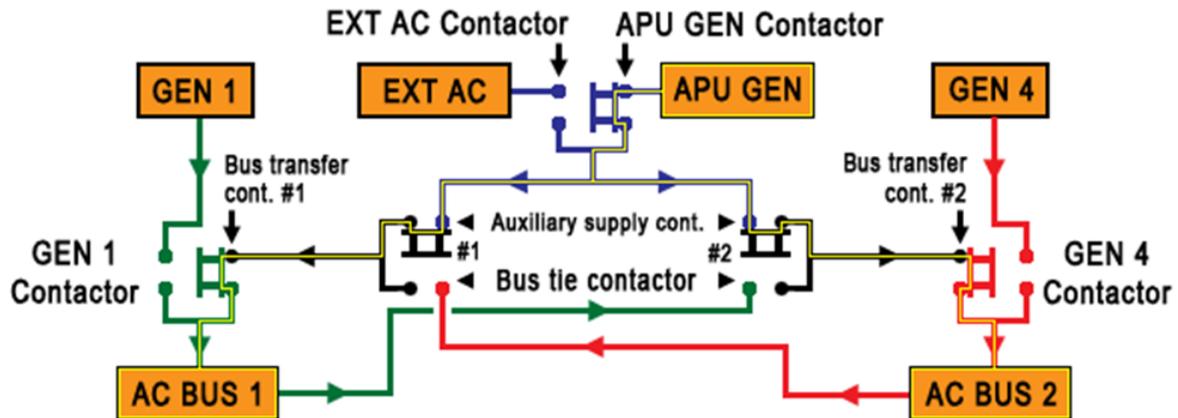
Figure 22: AC bus-tie and transfer system with APU GEN as the active power source

EXT AC is the least preferred method according to the aircraft's logic. You may use it to power the plane until engine start, but afterwards you'll want to use the APU and the APU generator. To do this, start the APU and set the APU GEN switch to ON.
Because the APU GEN is preferred over EXT AC, the EXT AC/APU GEN interlocked contactor will close the APU GEN circuit, breaking the EXT AC circuit. The rest of the contactors will remain as they were. You can see all this in Figure 22.

Main generators (GEN1/GEN4) in use
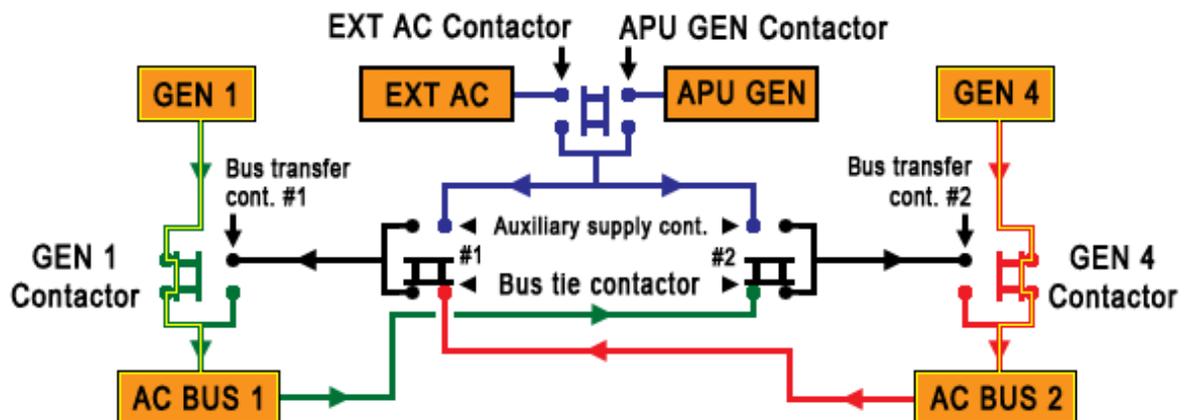
Figure 23: AC bus-tie and transfer system with the main generators (GEN1/GEN4) as the active power source

Far and away the most preferred option is to use the main generators, GEN 1 and GEN 4. These will become available when engines 1 and 4 are running. To turn them ON, set their switches to ON. The airplane's logic will then close the GEN 1 and GEN 4 contactors. By doing so, both bus transfer contactors will open, breaking contact between the APU generator and the AC busses. Instead, the generators will now power the AC busses. You can see this in Figure 22. You might have noticed in this schematic that the GEN1/GEN4 route is the simplest route. It involves only one contactor instead of three, and as such the main generators are also the most reliable power sources. But what if a generator fails? See Figure 53.

GEN 1 and bus transfer in use
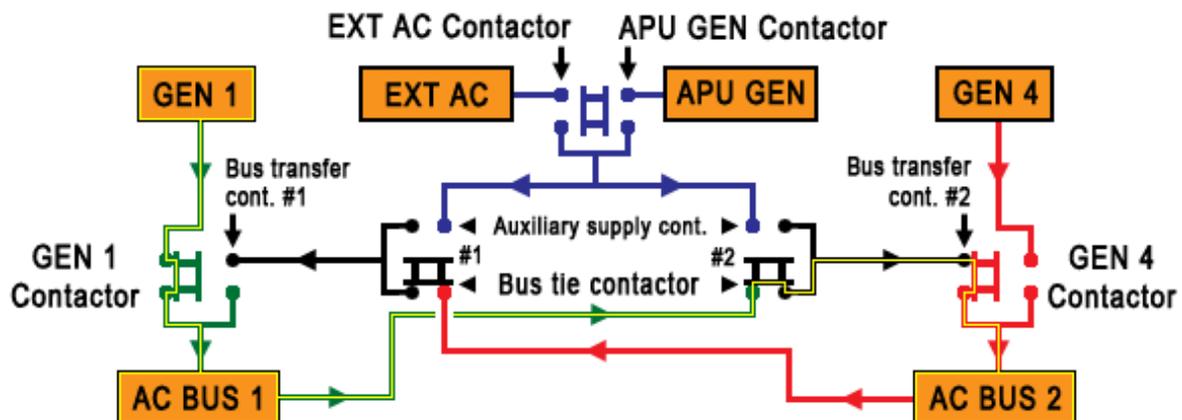
Figure 24: AC bus-tie and transfer system with GEN 1 as the active power source. GEN 4 has failed, and as such the bus transfer system has kicked in to keep AC BUS 2 powered.

In Figure 24 GEN 4 has failed, leaving only 1 generator available to provide power: GEN 1.
This would mean that only AC BUS 1 would be left with power. AC BUS 2 and the entire channel 2 would be unpowered.
Fortunately we have the AC bus-tie contactors, introduced earlier in this chapter. Keeping with the situation in Figure 24, bus-tie contactor 2 will close to close the circuit between AC BUS 1 and AC BUS 2. Via this circuit, AC BUS 1 supplies power to AC BUS 2 and as such complete channel 2 power loss is avoided. For this to happen, the AC bus-tie switch has to be set to AUTO, which is default in this product.

The situation in Figure 24 can also happen the other way around. In that case AC bus-tie contactor 1 will close to close the circuit between AC BUS 2 and AC BUS 1, so that power loss of channel 1 is avoided.

This explains what there is to know about the AC bus-tie and transfer system. It is a complicated system, but not incomprehensible. For the remainder of the chapter direct knowledge of the AC bus-tie and transfer system is not essential however, for we will deal again with power levels, as introduced earlier in this chapter. For this we will first go back to Figure 17.

Downstream of AC bus-tie and transfer system

The beef of the electrical system comes after the AC bus-tie and transfer system, yet it is also the more straightforward part. If we move back to one of the earlier chapter we read that, and I quote:

"…there are four distinct "layers":
       - The AC bus-tie and transfer system, shown within the grey area.
       - Components active at a normal power level.
       - Components active at an essential power level.
       - Components active at an emergency power level."

I already stated that the electrical system is built around the power level principle, so how does this work in practice?
To reiterate the power level principle: the higher the power level, the more components on board the aircraft are powered and functional. In practice this means that if you drop in power level, less components in the electrical system remain active. This happens because less busbars remain active. Figure 25 through Figure 27 demonstrate this.
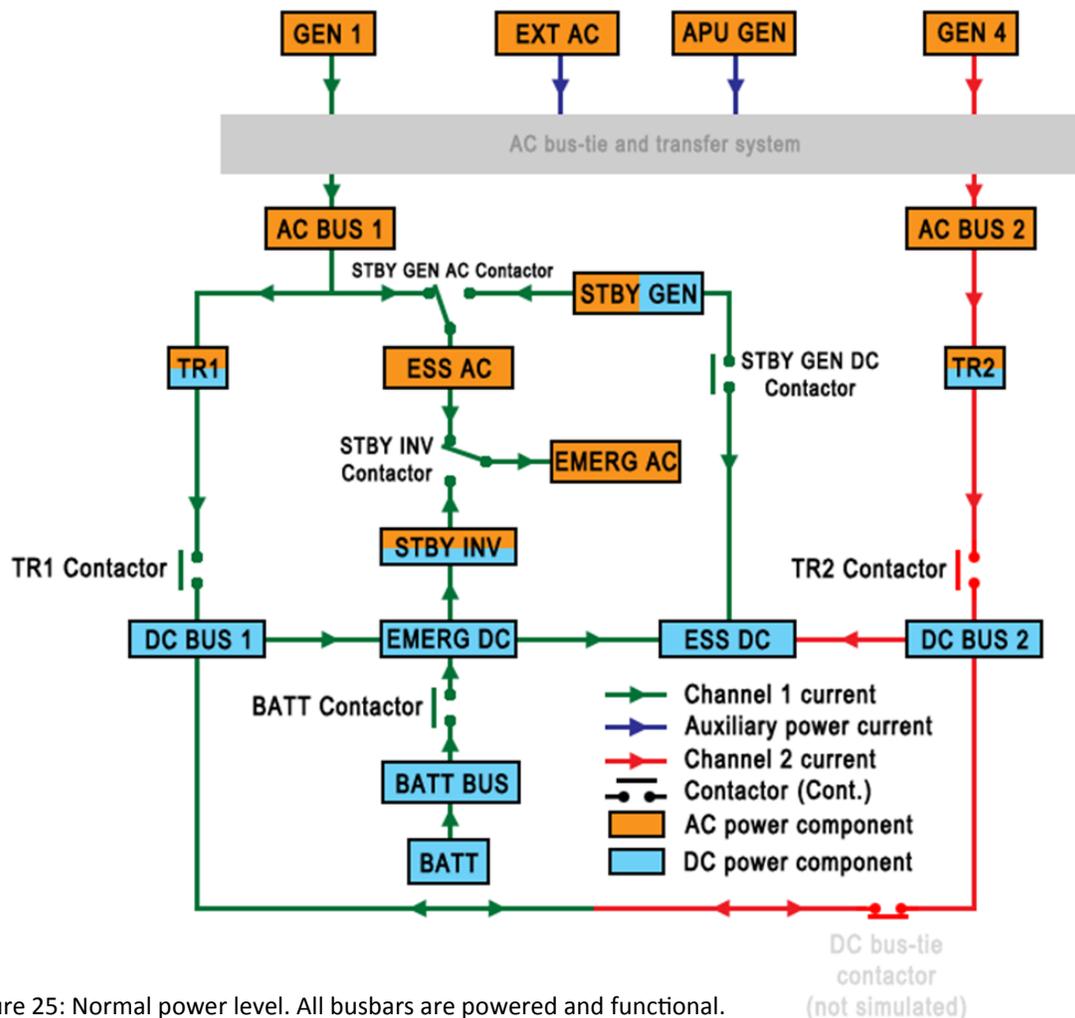
Figure 25: Normal power level. All busbars are powered and functional.

Figure 24 shows the normal situation. Via one of the principle power sources and the AC bus-tie and transfer system, all of the busbars are powered. We will go through each of the components in the correct order (from source to sink).

- As one or more of the principle power sources are active and online, the two main AC buses are powered (AC BUS 1 and AC BUS 2).

- The two main AC buses power the two main DC busbars (DC BUS 1 and DC BUS 2). They do this via the *Transformer Rectifiers* (TR1 and TR2). The TR is a component that turns AC power into DC power. Hence the split color of the icon in the schematic.

- AC BUS 1 also powers the essential AC busbar (ESS AC)

- The essential AC busbar powers the emergency AC busbar (EMERG AC)

- The two DC busbars each power a different component:

  - DC BUS 1 powers the emergency DC busbar (EMERG DC).

  - DC BUS 2 powers the essential DC busbar (ESS DC).

- Finally, the battery (BATT) powers the battery busbar (BATT BUS)

Although it would seem that I forgot something, I did not. Everything that is active in a normal situation with a normal power level has now been discussed. Any additional components will be discussed later.
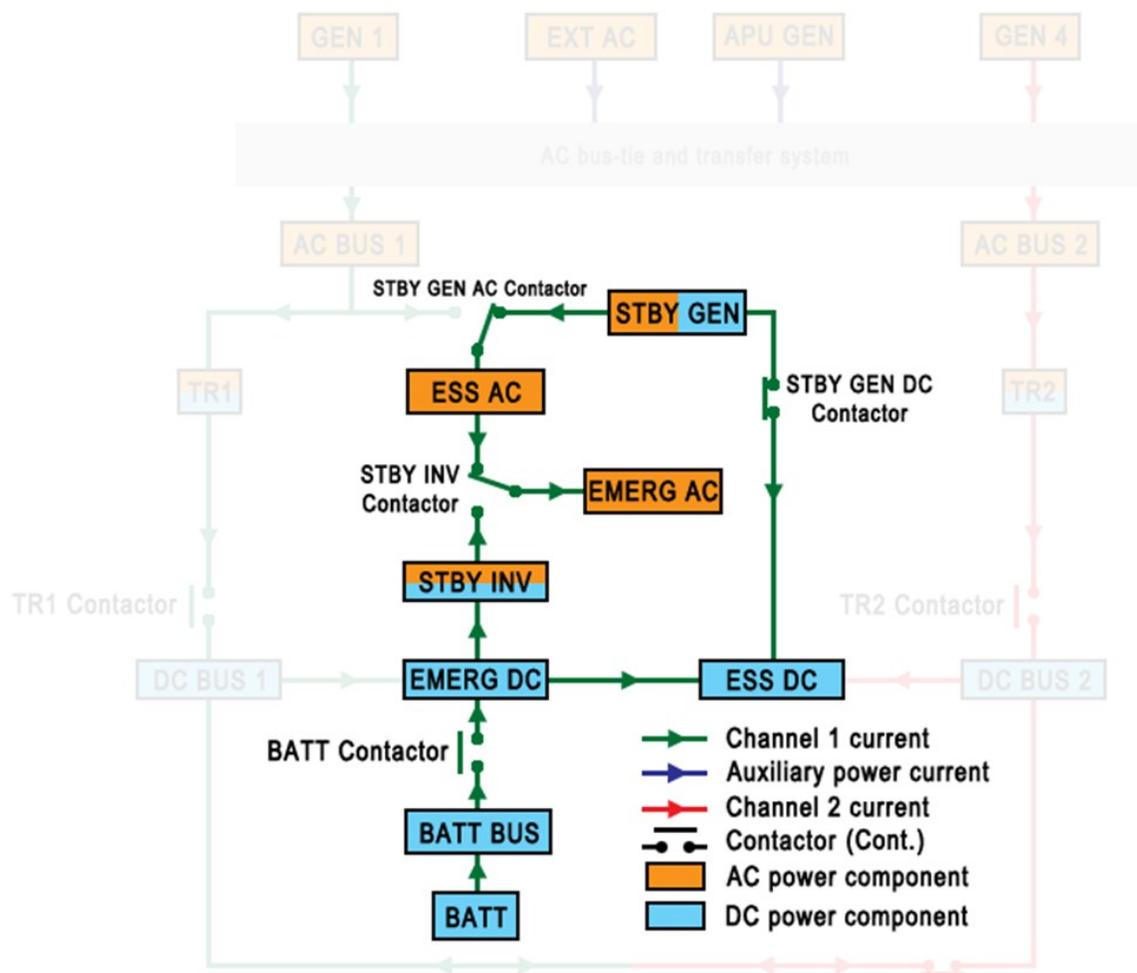
Figure 26: Essential power level. The main busbars are not active anymore

Essential power level, shown in the Figure above, gives a more condensed view of the electrical system. At this point the main generators have failed. If engine number 3 is still running, you can now engage the standby generator (STBY GEN). You can do this by selecting the STBY GEN switch to ARM.
In this mode, it will automatically start when the two main AC busbars are lost.
The standby generator can supply power to both emergency and essential busbars. The schematic in Figure 26 shows how this is done.

- The STBY GEN AC contactor will break the route via AC BUS 1, establishing contact via the STBY GEN in the process. Via this route, the essential AC busbar is powered.
- Like in the normal power level, the essential AC busbar powers the emergency AC busbar.
- The STBY GEN DC contactor will close, allowing the STBY GEN to power the essential DC busbar.
- The essential DC busbar can power the emergency DC busbar

As you can see, the essential power level is a second layer below the normal power level, and thus is "a system within a system". If armed, the electrical system's logic will engage the STBY GEN, thus activating the essential power level. While you will have lost all main busbars, the essential and emergency busbars still function.
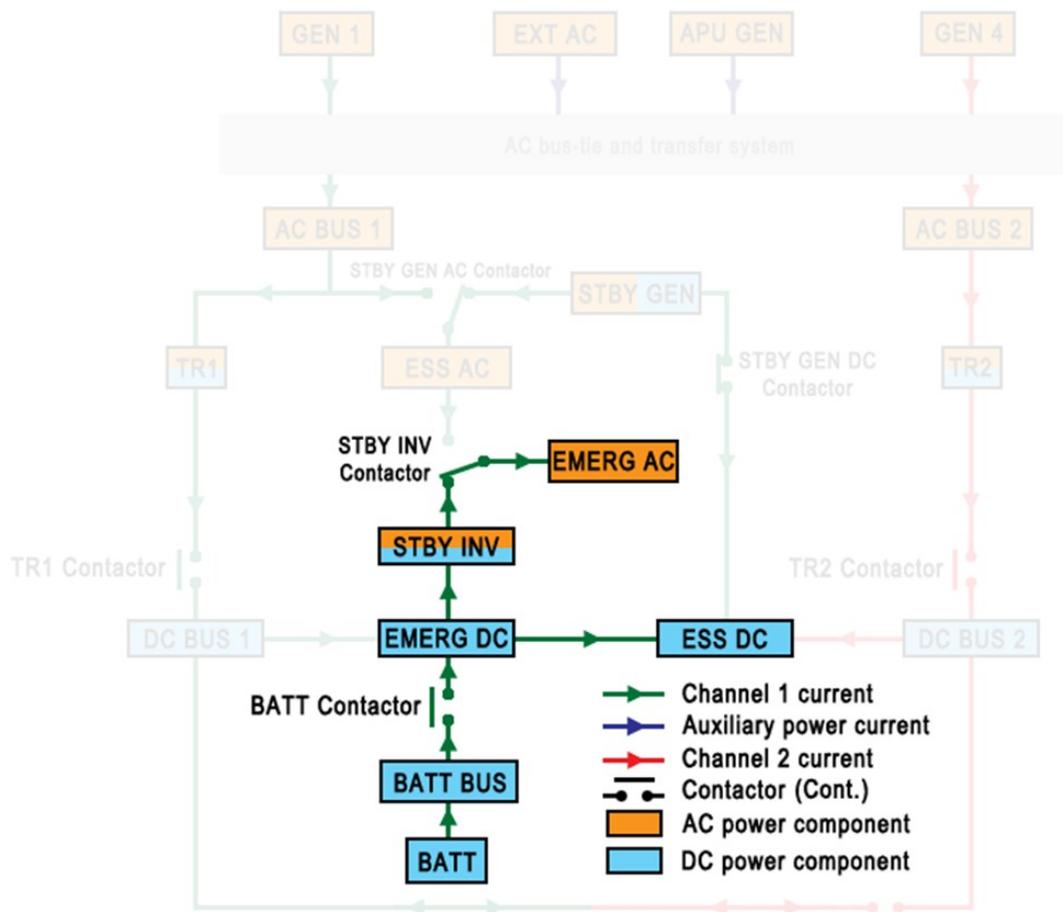
Figure 27: Emergency power level. Most of the busbars are inactive.

As you can see in Figure 27, the emergency power level truly is a base system. There are no additional power sources here besides the battery (BATT), and as such there is no possibility to engage extra power sources if need be.

The battery powers the most vital busbars in the following manner:

- The battery (BATT) powers the battery busbar (BATT BUS).

- The battery busbar powers the emergency DC busbar (EMERG DC).

- The emergency DC busbar powers the essential DC busbar (ESS DC)

- Via the *standby inverter* (STBY INV) the emergency DC busbar powers the emergency AC busbar (EMERG AC). The standby inverter converts DC power to AC power and as such is opposite to the transformer rectifier (TR) in function. However, unlike the transformer rectifier, the standby inverter has to be turned on for it to work! On the overhead panel you have to set the STBY INV switch to ARM, much like the STBY GEN switch. When armed, the standby inverter will automatically turn ON when essential AC power is lost.

With these three buses powered, the aircraft is still flyable. Expect much information to be missing from the cockpit, as key systems such as the EADI and EHSI will not work anymore. It is a good thing therefore that all hydraulic systems are dependent on engines 2 and 3, for you will still be able to control the plane, extend the gear and flaps and lift spoilers, even if you are confronted with massive power loss.

System summary

The electrical system consists of three key components: power sources, which supply power, contactors, which close or break circuits, and busbars, which are basically a multiple socket. The busbars represent all equipment on the aircraft that needs power, and these are powered by one of the power sources on the plane: either one or both of the main engine-driven generators, the APU generator, the external AC, the battery or the standby generator. There are eight busbars on board: 4 main busbars, two essential busbars and two emergency busbars, all of which have AC and DC variants.

The electrical system is a big and complicated system, but understanding it is made a lot easier if you think of it in terms of *power levels*. These are layers built on top of each other, acting like a "safety net". The top-most layer is the normal power level and supplies power to all busbars and is dependent on the two main generators. If the main generators fail, the main busbars lose power. When the main AC busbars power loss is detected, the standby generator will engage. It will power the emergency and essential busbars, which is why the next power level is called the *essential* power level. If the standby generator fails also, then the battery is all that is available to power the plane. The battery can only power the two emergency busbars and the DC essential busbar, which is why this power level is called the *emergency* power level. After emergency power level, there is no safety net, and as such, the emergency power level can be considered as the base electrical system.

LIGHT CONTROLS

FLT DECK EMERG LIGHTS switch

Turns the emergency lights ON, OFF, or ARMs them in case of an emergency

RWY EXIT LTS switch

Turns the runways exit lights ON or OFF (NOTE: Due to Limitations this is tied to the Taxi Lights)

LANDING LTS / TAXI LTS switches

Turns the landing lights ON, OFF, or enables taxi lights (TAXI LTS) only

SCREEN WIPERS switches

Turns the screen wipers on in a FAST or SLOW mode, or turns them OFF

FASTEN BELTS switch

Enables you to turn the cabin seatbelt signs ON or OFF
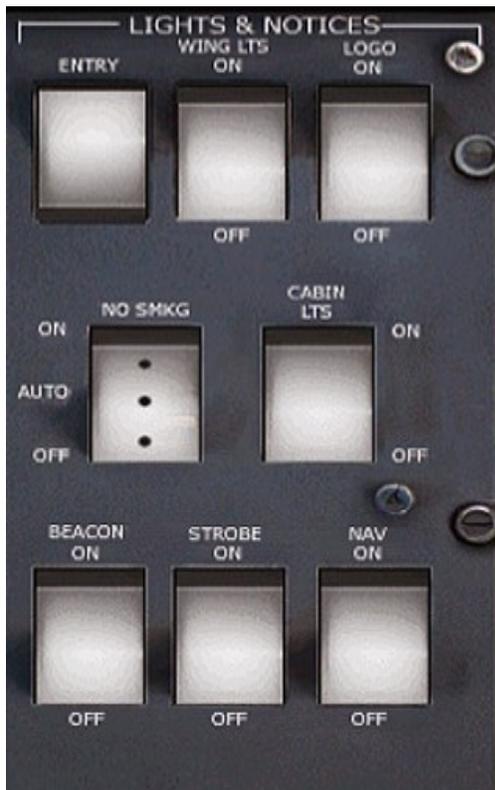
ENTRY

Turns the flight deck entry light ON or OFF

WING LTS switch

Turns the wing inspection lights ON or OFF

LOGO switch

Turns the vertical stabilizer's logo light ON or OFF so as to illuminate the logo on the vertical stabilizer

NO SMKG switch

Turns ON or OFF the No Smoking Signs in the cabin, or sets it to AUTOmatic. In the latter mode, the signs will turn ON or OFF based on the nose gear being retracted or extended

CABIN LTS switch

Turns the cabin lights ON or OFF

BEACON switch

Turns the blinking, red beacon light ON or OFF

STROBE switch

Turns the various blinking, white strobe lights ON or OFF

NAV switch

Turns ON or OFF the navigation lights on the wingtips and tail

HOW TO USE

Using the lights is as simple as knowing when to turn them ON and OFF. Below we have provided a list with details about this:

TAXI Lights
> *Taxi lights are to be used at all times when maneuvering on the ground, during climb and descent below 10 000 ft*

LANDING Lights
> *Landing lights are to be used for take-offs and landings*

NAV Lights
> *Navigation Lights are to be turned ON whenever there is any activity in the aircraft*

BEACON Light
> *The Beacon Light is to be turned ON whenever the engines are turning or about to turn*

STROBE Lights
> *Strobe Lights are to be turned ON whenever the aircraft is on a runway or in the air*

WING Lights
> *Wing Lights are to be used as required. Usually during take-offs and landings in night time.*

LOGO Light
> *The Logo Light is to be used as required. Usually on the ground in night time.*

ENTRY Light
> *The Entry Light is to be used as required. This is also commonly known as Dome Light.*

CABIN Lights
> *Cabin Lights are to be used as required. Usually OFF during take-off and landing.*

SYSTEM DESCRIPTION

The BAe/Avro series formally have two light panels. One panel is located at the very front of the overhead panel, and contains only a small selection of the available light switches plus some non-light switches, such as windscreen wipers. The other panel is placed at the very back of the overhead, adjacent to the circuit breaker panels on the overhead. Here you will find many common light switches, such as strobe light, navigation lights and beacon light switches.

AUXILIARY POWER UNIT (APU)

FIRE EXT DISCH Switch (not simulated)
> *This switch DISCHarges the APU's fire EXTinguisher*

RPM gauge
> *This gauge shows the APU's RPM*

Start/Stop switch
> *This switch initiates the start sequence of the APU, or enables the crew to shut the APU down*

APU FIRE annunciation light (not simulated)
> *Indicates a fire detection in the APU bay*

LOOP FAULT annunciation light
> *Indicates that a fault has been detected in the APU's fire loop*

APU EXT USED annunciation light (not simulated)
> *Indicates that the APU's fire EXTinguisher was discharged*

APU PWR AVAILABLE annunciation light
> *Indicates that the APU is ready for use and can be connected to the various aircraft systems*

EGT gauge
> *This gauge shows the APU's Exhaust Gas Temperature (EGT)*

APU AUTO SHUTDOWN annunciation light
> *Indicates that the APU has been automatically shut down*

APU FUEL LO PRESS annunciation light
> *Indicates low fuel pressure at the APU's fuel inlet*

APU FUEL VALVE annunciation light
> *Indicates that the APU's fuel valve is not in the position commanded by the APU's start/stop switch (at start it should be open, closed at stop)*

APU NRV LEAK annunciation light
> *Indicates that the engine provided air is leaking into the APU air supply duct*

HOW TO USE

You will want to use the APU before engine start, and possibly after landing also to power the plane when no external AC is available. In order to **start the APU** successfully, these are the steps to follow:

1. Switch the **Battery ON** if you have not already done so
2. Set **START MASTER switch** to **OFF** if not already set to OFF
3. Set **APU Start / Stop switch** to **START**
4. Monitor APU **EGT** and **RPM** gauges
5. Wait for the green **APU PWR AVAILABLE** annunciation light to illuminate.
6. The APU is now ready for use

To shut down the APU, simply set the **APU Start / Stop** switch to **STOP**. You will see RPM and EGT go to zero immediately.

SYSTEM DESCRIPTION

APU Overview

The APU, or Auxiliary Power Unit, is an engine that can power the plane while on the ground. And provide vital services for initial aircraft preparation and start-up at the cost of aircraft fuel (which is the reason that most airlines prefer to use the APU only when the engines are started, using a Ground Power Unit (GPU) while at the stand). While on, the APU provides electric power via an AC generator and pneumatic power via compressed air. To enable these methods of power delivery, switches can be set as needed on the relevant subpanels on the cockpit overhead panel.

Historically, the BAe/Avro series has always seen two APUs in service, being either the Garrett or Sundstrand APU. In the Ultimate BAe Series, only the Sundstrand APU has been simulated, however, but in practice the crew will not notice much difference, for the only difference that is visible to the crew is very minor variation of the APU EGT gauge, which for the Garrett APU reads "APU TGT" on the APU subpanel. It is via this subpanel, that the crew has excess to the basic APU related functions, including the start and stop switch and emergency fire extinguishing apparatus. Several subsystems make the APU function the way it does. Briefly, these are:

– The *Electronic Sequencing Unit (ESU)* starts and stops the APU without further attention of the crew being necessary

– *Fuel feed lines* connect the APU to the aircraft's fuel feed system

– The *APU generator* is what supplies the aircraft with electrical power when the APU is turned on and ready to supply power

– The *Oil system* lubricates the APU generator, allowing it to run smoothly at all times. A special fan cools the oil

– *Fire protection and suppression* systems that detect fire and, depending on whether the plane is on the ground or in the air, will automatically extinguish and shut down the APU

– *Air supply ducts* to make use of the APU's pneumatic capabilities, most notably used for engine start

APU fuel supply

You can see in Figure 28 that in principle, the left inner feed tank provides the APU with unrestricted fuel. Unrestricted, because if you'd want to use any of the other feed tanks, suitable selections have to be made regarding the cross and common feed valves. However, before fuel can flow into the APU's combustor, a single low-pressure (LP) valve has to be opened: the APU LP valve (see Figure 28 for its position). This valve is signaled by the APU start/stop switch on the APU overhead subpanel, or by an emergency APU shutdown. The APU start/stop switch is a direct command to the valve top open if the switch is set to START, and to close if the switch is set to STOP. During emergency shutdown, the valve is commanded to close.
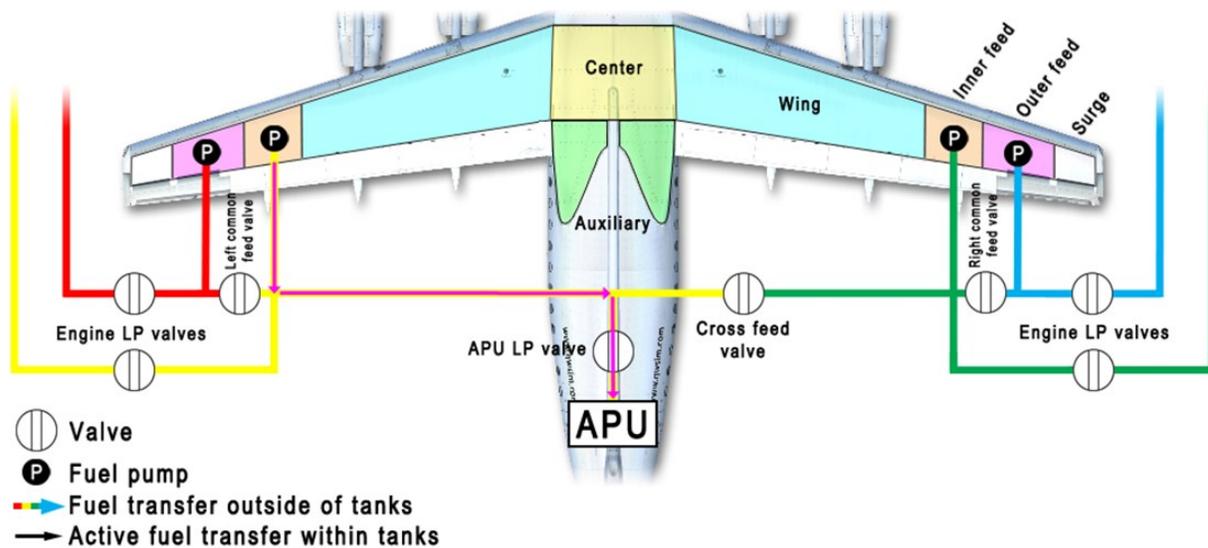
Figure 28: Reduced fuel system schematic to show the most direct path of the fuel to the APU (magenta line). Of course any of the other feed tanks may also feed the APU fuel, but suitable selections will have to be made regarding the common and cross feed valves.

There are two paths the fuel can take once past the APU's LP valve and once past the hydro-mechanical governor that will manage APU RPM once APU start is complete.

– One path leads to the APU's start fuel valve. This fuel valve is opened during the first stages of APU start, at 3% RPM. It is closed at 85% RPM.

– The fuel can also travel to the main fuel valve, however. The main fuel valve is first opened at 14% RPM, but is only fully opened at 50% RPM. Between 14 and 50% RPM, the ESU opens and closes the main fuel valve so as not to overheat the APU due to excessive EGT. It does this according to compressor pressure information it receives from an acceleration control. Acceleration control is a module that enables controlled acceleration of the APU. In other words, it manages APU RPM and makes sure it doesn't increase too swiftly. It does this by telling the ESU how much fuel may enter the APU through the main valve (this is logical if we think back to the APU's second operating principle). Subsequently, when the APU has reached 90% RPM, the main fuel valve isn't fully opened anymore. Instead, it is opened by as much as needed to maintain the hydro-mechanical governor's speed.

There are two amber annunciation lights on the APU overhead subpanel related to the APU's fuel supply:
– **APU FUEL VALVE** will light up whenever the APU LP valve is not in the commanded position by the switch. For example, if the APU *was stopped* but the APU is being started up again, the valve will have to open to allow fuel access to the combustor. While the valve is in transit to its new position, this annunciation light will come on.

– **APU FUEL LO PRESS** indicates that low fuel pressure was detected at the APU's fuel inlet, because only a little or no fuel at all is reaching the APU. This is an indication that the APU isn't being fed by a feed tank. Suitable selections should be made in order to get the fuel from the feed tanks to the APU (see Figure 28).

Note that at APU start, it can suction feed, meaning that it will suck fuel out of the feed tanks into the combustor. However, when the APU is running, a fuel pump should be running. The left inner fuel pump would be most common due to the direct link of the APU with the left inner feed tank, but it's not mandatory. As long as the correct cross and common feed valve settings have been made, any and every fuel pump can be used to provide the APU with fuel.

APU power provision

As was said, the APU provides the aircraft with two types of power: *electrical* and *pneumatic* power. Electrical power is made available due to the turning motion of the turbine. When it is coupled to an AC generator, it will provide the aircraft's main AC busbars with electrical power. To connect the APU to the AC generator, the switch APU GEN on the electrical panel should be set to ON.

Pneumatic air is supplied via an air duct that feeds the aircraft's air supply system. The air comes from the APU's compressor, and as such it is high pressure, compressed air that enters the air supply system. A valve will be enabled for opening once the APU is ready to supply power. It can be manually opened using the APU AIR switch on the air supply subpanel on the overhead. The valve will automatically close when the APU is signaled to shut down either by the automatic shutdown or the crew setting the APU start/stop switch to STOP.

System summary

The Auxiliary Power Unit, or APU, is like a tiny jet engine built into the rear of the aircraft. It is used as a power and pressured air source when the aircraft engines are not started yet and as such cannot deliver electrical, air and hydraulic power.

The APU is started using the APU panel, which sees various components become active at several moments in time, until the APU can keep itself running by an electronically controlled fuel supply.

The mechanical functioning of the APU relies on a compressor and a turbine. During APU start, a start motor turns the compressor and turbine, which are all located on a single shaft. Once the RPM is high enough, fuel will enter the combustors and be ignited. This serves the purpose of speeding up pressured air that enters the combustors via the compressor. This accelerated, high-pressure air then drives the APU's turbine by pushing its rotor blades "aside" while leaving the APU. Due to more fuel being let into the combustor, more fuel is ignited, resulting in are gaining a higher speed. Due to the air going faster, the turbine will also rotate faster. Because the turbine and compressor are located together on a single shaft, the turbine will drive the compressor. As long as fuel will enter the combustor, the APU will as such keep turning: air will be sucked into the compressor, where it will be pressurized. It will then move to the combustor, where it will receive higher speed. Finally, it will go through the turbine, making it rotate. Because the turbine rotates, the compressor also rotates.

When the APU has started and has a sufficient RPM, it can be coupled to the APU generator and power the aircraft that way. It can also supply air for the air conditioning system.

—INTENTIONALLY LEFT BLANK—

ENGINES & ICE PROTECTION

START PWR switch

Selects the power source for engine start on the ground. At EXT DC, an external DC supply is used (not simulated). At NORM, an external AC supply, the APU's generator or an engine generator can be used. At COLD only an external AC supply can be used (not simulated).

START SELECT rotary selector

Enables you to select the engine to be started

START MASTER switch

Selecting the switch to ON powers the engine start busbar and thus readies the engine start process for the selected engine. At OFF, the engine start busbar is not powered and engine start will not commence. For actual engine start, the ENGINE switch is used.

START PWR ON annunciation light

Annunciation light indicating when lit that the start busbar is powered.

ENG IGN A ON annunciation light

Annunciation light indicating that the selected engine's A igniter is powered. Igniter selection is on the avionics panel. Select the engine using the START SELECT knob.

ENG IGN B ON annunciation light

Annunciation light indicating that the selected engine's B igniter is powered. Igniter selection is on the avionics panel. Select the engine using the START SELECT knob.

STARTER OPERATING annunciation light

Annunciation light indicating that an engine's starter motor receives a voltage.

FLT START switch (not simulated)

Used only for in-flight engine start. Not simulated.

CONT IGN A and B switches

Separate switches for the A and B igniters enable continuous ignition of either the A and B igniters or both at the same time. When continuous ignition is turned ON, the ENG IGN A/B ON annunciation lights will not illuminate to say that the igniters are ON.

ENGINE switch

> *Enables ground engine start. The switch is spring loaded from START to RUN and from MOTOR to RUN. When held at START or at MOTOR, it will jump back to RUN when released. When held at START, the engine start sequence is initiated for the selected engine (selected with START SELECT) if the START MASTER switch is set to ON. When held at MOTOR, the ground motoring sequence will be initiated. During ground motoring, the igniters are not powered.*

INTAKE 1/2/3/4 HI PRESS annunciation light

> *Annunciation light indicating that a higher than normal pressure was detected in the engine's associated anti-ice valve (1, 2, 3 and/or 4)*

INTAKE 1/2/3/4 LO PRESS annunciation light

> *Annunciation light indicating that a lower than normal pressure was detected in the engine's associated anti-ice valve (1, 2, 3 and/or 4)*

ENG 1/2/3/4 VLV NOT SHUT annunciation light

> *Annunciation light indicating that the engine's associated anti-ice valve is not shut.*

ENG 1/2/3/4 ANT-ICE switches

> *Four switches turn ON or OFF the engine's associated anti-ice system. At ON the engine's associated anti-ice valve is opened, at OFF it is closed.*

HOW TO START THE ENGINES

Note that here it will not be explained how to control thrust with the thrust levers.
Here follows a quick guide to **starting the engines**:

1. Set **START MASTER switch** to ON

2. Choose the ignition circuit: A, B or Both. *(Upper Left Overhead Panel)*

3. Select the engine to start using the **START SELECT rotary selector.**

4. Hold the **ENGINE switch** in the START setting for a few moments; then release the switch.

5. Monitor the selected engine's N2 RPM.

6. At 15% N2 RPM, set the selected engine's thrust lever to IDLE
   (right click below the appropriate thrust lever)

7. Wait for the engine to reach idle thrust.

Congratulations. The engine is now successfully started!

Stopping the engines is done by moving the thrust levers to the OFF detent.
(right click below the thrust lever)

SYSTEM DESCRIPTION

Engine systems overview

The engine systems on board of the Avro/BAe series of aircraft are spread all over the cockpit. Parts may be found on the overhead panel (discussed here), on the Mode Control Panel (MCP), on the main instrument panel and on the throttle quadrant. As such, a single, comprehensive explanation of the engines and their support and controlling systems in the context of the related overhead subpanel is nigh on impossible. To counter this, expect references to and from engine related panels throughout this manual. However, you can expect the beef of the engine related system to be explained here.

The engines are a complicated mess of core and support systems. Unlike the previously discussed systems, they are not "pure", but involve many different systems to aid their functioning. Whereas the hydraulics and fuel systems on the aircraft are just that - hydraulics and fuel systems – the engines are where these systems come together and help support exactly that which ends up driving everything on the aircraft. Because of this, it should be no surprise how much the main engines resemble the APU. Remember the APU's core operating principles, and you'll see the engines function by much the same principles.

In order to start, manipulate and stop the engines and exploit them for various services so that the aircraft can power and maintain itself during flight, an array of subsystems is necessary:

– *FADEC*, or *Full Authority Digital Engine Control*, is an invaluable electronic system that takes throttle quadrant input and forwards it on to the engines electronically. While it does that, it checks for operating limits based on the current configuration of the aircraft and makes sure that the engines always operate correctly. FADEC also helps during engine start.

– *AutoThrottle* (A/T), *Thrust Rating Panel* (TRP) and *Thrust Modulation Control* (TMC) are systems that enable an automatic or semi-automatic throttling mode. In the case of autothrottle, throttle is automatic. With TMC, it is semi-automatic. The pilot has to set the throttle levers in roughly the right position (indicated by blue and white arrows on the main instrument panel), and TMC will "trim" the engines to match the thrust rating set on the TRP. Note that TMC is not simulated in the Avro RJ.

– *Fuel feeds* enable the fuel flow to the engines, much like with the APU.

– *Ice protection* ensures that in humid, cold environments (such as clouds) no ice is formed on the engine nacelles or fan blades, which could result in catastrophic failures.

– *Bleed air* will, after engine start, supply the air supply system with air for air conditioning and pneumatic services.

– The engines power *hydraulic services* after start.

– *AC generators* will supply the aircraft with AC power to power all the systems on the aircraft after gine start.

Engine start logic

A wide array of switches and circuits has been introduced in the previous topic. We will now analyze each one of them and provide a framework for them. For this we use Figure 29. You will notice that it resembles the APU's start logic – this is indeed the case, for the APU and engine start make use of the same base circuits. See Figure 29.

Figure 29: Schematic of the start motor circuits: what buttons, switches and knobs need to be set in what way in order to power an engine's start motor. Grayed out is either not simulated or not relevant for this topic.

Figure 29 probably seems overwhelming at first, so take a deep breath and let's get digging. Like with the APU start circuitry, the main goal here is to get the start busbar powered. When that happens, the white START PWR ON annunciation light will illuminate on the Engines subpanel. Before that happens, however, several contactors will have to be closed. These contactors are closed by the START MASTER and START PWR switches.

The START MASTER switch is what the name says: a master switch for engine start. If it's OFF, the engines won't be started because the busbar will remain unpowered. As such, you may look upon it as a safety switch that you have to manually set correctly for engine start. The START MASTER switch is not really what chooses the power source to be used for engine start, however. From the APU chapter, you might remember that there the START MASTER switch played a big role in determining the power source to be used for APU start. For engine start it plays less of a role, for the reason that to start the engines, you will always have to set the START MASTER to ON, *regardless of the power source*.

All in all, the aircraft has three power sources to start the engines from (see also Figure 29):

−   EXT DC: For this an EXTernal DC source has to be plugged into the aircraft. This is not simulated.

−   BATT: The aircraft's battery is used, only for emergencies and it wasn't even fitted on every plane. This is not simulated.

−   TR 1 and TR 2: these transform AC power into DC power from:
    a.   An external AC source (the GPU)
    b.   The APU
    c.   Another engine (cross start)

Only one of these sources can be connected to TR 1 and 2 at a time!

The power source to be used can be selected using the START PWR switch. The switch has three positions: EXT DC, NORM and COLD. On the Ultimate BAe Series, only NORM is simulated, but we'll go through all modes regardless:

−   At EXT DC, an EXTernal DC power supply is used. Looking at Figure 29, setting the switch to EXT DC will close the *upper* contactor. If you now set START MASTER to ON, the start busbar will be powered by EXT DC. This function is, however, not simulated.

−   NORM is the NORMal setting for this switch. In Figure 29, the blue arrows show what contactors will be closed when the switch is set at NORM. As can be seen there, the upper contactors of the TR 1 and TR 2 routes are closed. This will prompt TR 1 and TR 2 to power the start busbar if START MASTER is set to ON.

    To power TR 1 and TR 2, an EXTernal AC source, the APU or another engine may be used to deliver the required AC power. Only one source can be connected at a time, however. The crew may select the source to be used by pressing the relevant switches on the Electrical subpanel on the overhead. Starting via the APU is the preferred method, however. It is operationally simpler. Using an EXTernal AC source may conserve APU life, however. Note that cross-start is not recommended. If not handled correctly, the engine-to-be-started start motor may be damaged. We recommend to use either APU or EXTernal AC in all circumstances.

    You will remember from the APU topic that you may *never* start the APU using START MASTER ON and START PWR at COLD or NORM, due to the fact that both TR 1 and TR 2 will power the start busbar. This will result in 28V powering the APU start motor, and as a result the APU start motor will have too high a torque and end up damaging itself. Instead, only TR 1 may supply power for the APU start motor. For engine start, both TR 1 and TR 2 are necessary, however. For this reason, when you set START MASTER to ON and START PWR to NORM, both TR 1 and TR 2 contactors are closed. As a result, if one of the two TRs are not working, engine start via the TRs cannot commence and engine start via EXT DC will have to be done.

−   At COLD, TR 1 and TR 2 will also power the busbar, with one difference: whereas at NORM the external AC, the APU or another engine can power TR 1 and 2, at COLD only an external AC source will power TR 1 and TR 2. The voltage will be 36V.

The keen observer will have noticed that the START PWR switch does not have a setting for BATT. That's quite correct! So how does the crew perform an emergency engine start using the battery? The answer is that they use an entirely different switch. First of all START MASTER has to be set to ON, and START PWR has to be set to either NORM or COLD. Next, the crew momentarily presses the EMERG START switch. Note that this button is not simulated in the Ultimate BAe Series.

We have now discussed all the circuitry involved in powering the start busbar. When the start busbar is powered, a white START PWR ON light will illuminate on the Engines subpanel. It is also the sign that we can continue priming the engine start subsystems and thus ready them for engine start.

One of these subsystems to be primed, or armed, is the start motor for the engine to be started. As you know, the start motor acts like a sling: it connects to the engine's main axis via a clutch that rotates it. The start motor's function in relation to the engine is best compared to *bleed air* in Boeing and Airbus aircraft. In these aircraft, air is blown against the engine's fan blades that will make them rotate and ramp up the engine's RPM until it's sufficient for fuel light up and subsequent engine start. The BAe/Avro series does not use bleed air for this, but a *start motor*.

The start motor is connected to the start busbar, like the APU's start motor is too. However, like with the APU's start motor, it is not connected directly to the start busbar. If this were the case, it would immediately operate once the start bus bar is powered, and that's not what we want. Instead, there is a *starter contactor* between the start motor and the start busbar, which is also displayed in Figure 29. If you remember, the APU's starter contactor was signaled by the APU start/stop switch. When the you set this to START, the APU starter contactor is closed, and the APU start motor turns ON, ramping up RPM and rotating the APU compressor and turbine in the process. It's more or less the same story for the engine's starter contactors. These are signaled by the ENGINE switch on the Engines subpanel on the overhead: when held at START for a few moments, the starter contactors close, so that power from the start busbar can reach the engine's start motor. At this point, the following happens:

− The STARTER OPERATING annunciation light on the Engine subpanel will illuminate, to signify that a voltage was detected over the start motor.

− The start motor will turn ON. It will ramp up RPM and turn the engine's main axis.

We are not quite there yet, because there are four engines and only one APU. Look at Figure 29: each engine has its own start motor circuitry, and thus each engine has its own starter contactor. How does the logic now which starter contactor has to be closed? For what surely doesn't happen, is that all starter contactors close. This would result in all engines starting at once, which is surely not what we want. No, before we even press the ENGINE switch and hold it at START for a few moments, we select the engine to be started. This is done using the START SELECT rotary knob. The START SELECT knob does not actually close a contactor, as you should now understand. Instead, it only *signals which contactor should be closed* when the start sequence is initiated. The actual closing of the contactor is done when the ENGINE switch is held at START. The FADEC will take over most of the start sequence now, as was explained in the previous topic.

Engine operating principles

We have now reached the point where the engines are actually started. This seems like the right time to give the engines themselves a look and see how they function. In all honesty, the basic operating principles are the same as the operating principles of the APU. The build of the engines is, however, different. See Figure 30 for an operational schematic.
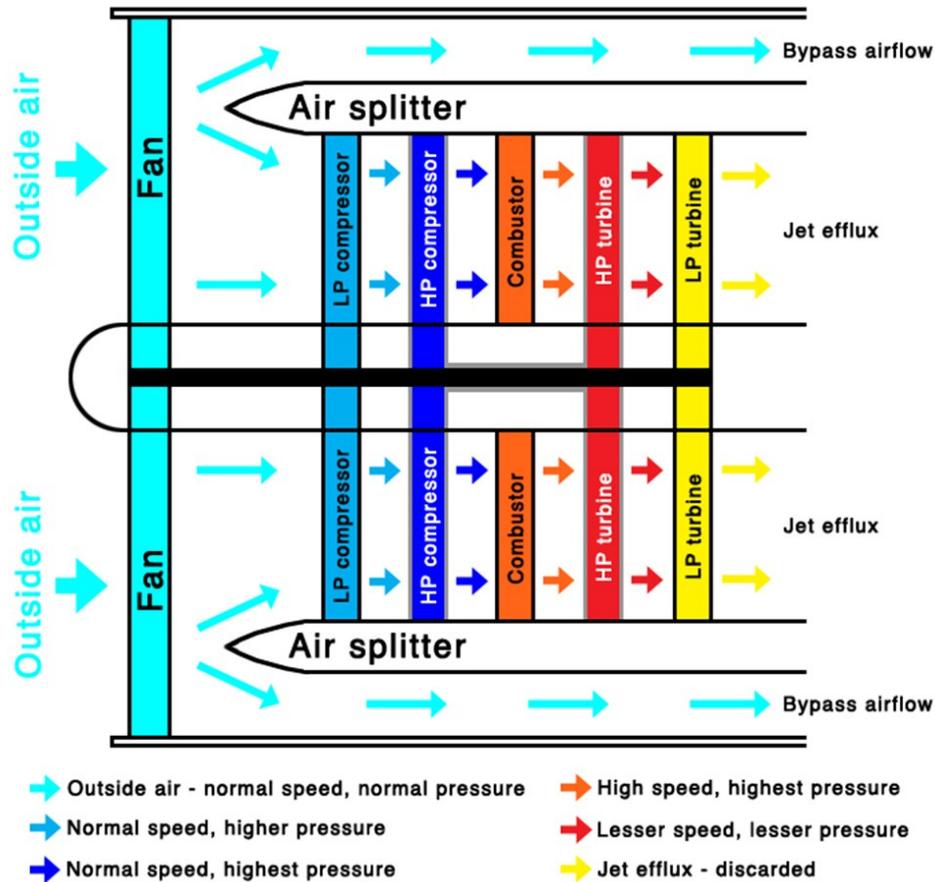
Figure 30: operational schematic of the engines. The arrows show the path of the air through the engine. The color of the arrows hints at the speed and pressure of the air, but their exact meaning is displayed in the legend in the figure. HP stands for High-Pressure; LP stands for Low-Pressure. Note that the various parts in the schematic are not scaled to their right proportions

Figure 30 is only a very schematic overview of the mechanism of the engine. What you see is a complete engine, but "cut in half". We are looking at the left lateral side. Some parts will be familiar to you, others will seem more complicated. At its heart, however, this engine doesn't work any differently than the APU. The basic three are still present: compressor, combustor and turbine. They are only more numerous and some of them have been split in *high-pressure* (HP) and *low-pressure* (LP) variants. Also, of note is that LP and HP parts are combined on a single spool. So, the LP compressor, fan and LP turbine are on the same spool (black in Figure 30 and the HP turbine and HP compressor are together on one turbine (dark grey in Figure 30).

To enter the engine, the air passes a fan first. These are the fan blades you see from the front of the engine. The air that is "captured" by the engine inlet is "scooped" into the engine by the fan, and is accelerated by the fan in the process. The air is thus accelerated, but otherwise it has seen no significant state changes yet. The air bumps into an "air splitter" next, where it is split to go into either one of two ducts. The first, upper duct is the bypass duct. The bypass duct leads the air around the core of the engine. The air that goes through here will produce the bulk of engine thrust.

The other duct leads the air to the core. First it goes through a low-pressure (LP) compressor. This is the first instance where air is compressed, and as such air with higher pressure comes out of it. Next it flows to the high-pressure compressor, where it is compressed even further. When the air comes out, it is at an even high pressure than it was before. At this point, the air flows into the combustor, where it provides oxygen to the fuel that comes into play here. Here is where combustion takes place, and during this process kinetic energy is transferred to the air, speeding it up significantly. Not all air is used for combustion, however. Some air is used to cool the combustor and high-pressure (HP) turbine, which is the next stage: after combustion, the air flows through the HP turbine. It is at a higher speed than before and still is at a high pressure. Flowing through the HP turbine, the air makes the HP turbine rotate. Due to the fact that the HP turbine is connected to the HP compressor via a spool, the HP turbine keeps the HP compressor rotating. Finally, the air, now with less kinetic energy than before, passes the low-pressure (LP) turbine. This LP turbine is also rotated due to the air that passes through. The LP turbine is connected to the fan and LP compressor via a spool, so because the LP turbine rotates, the fan and LP compressor are also rotated. At long last, the air exist the engine via a nozzle. The jet efflux is discarded mostly, although it has a small contribution to thrust.

We see the same in this engine as with the APU: Once the HP and LP turbines have reached a sufficient RPM, they will drive the compressors with sufficient RPM to keep the engine running. During engine start, it is at 40% N2 RPM that this point has been reached: the start motor disengages via clutch and the starter contactor is opened for that engine's start motor. The FADEC will then ramp up the engine's RPM to its IDLE setting. It has now become a self-contained thing that will only stop once the fuel is cut and no combustion can take place any longer. The whole system relies this way on the successful entry of fuel into the combustor. For this reason, we will now contemplate how this works.

Engine systems

The goal, and the reason engines are attached to an aircraft, is for the engine to provide thrust. To do this, fuel has to be burned and, as explained previously, for this to happen fuel needs to get to the combustor. As such, every system related to the engines is in some way connected to the engine's fuel supply, whether directly (such as the various fuel pumps) or indirectly (such as the FADEC ECU). However, not one system is entirely detached from the engine's fuel supply system, and as such it is in the context of the engine's fuel supply system that all related engine supporting system will be discussed.

Following that logic, contrary to what one might think, the engine's fuel supply isn't just a duct leading straight from the aircraft's fuel system to the combustor's fuel inlet. There's a whole array of pumps, systems and logic running to *dose* the amount of fuel that gets into the combustor, and that gets it there with the right pressure and temperature. Why is it important to dose the amount of fuel? As explained previously, the amount of fuel that gets burned is a direct factor for engine RPM and thus thrust.

Figure 31 offers a simplified schematic of some of the core systems involved. We will follow the path the fuel takes through the engine and discuss the various systems as we pass them.
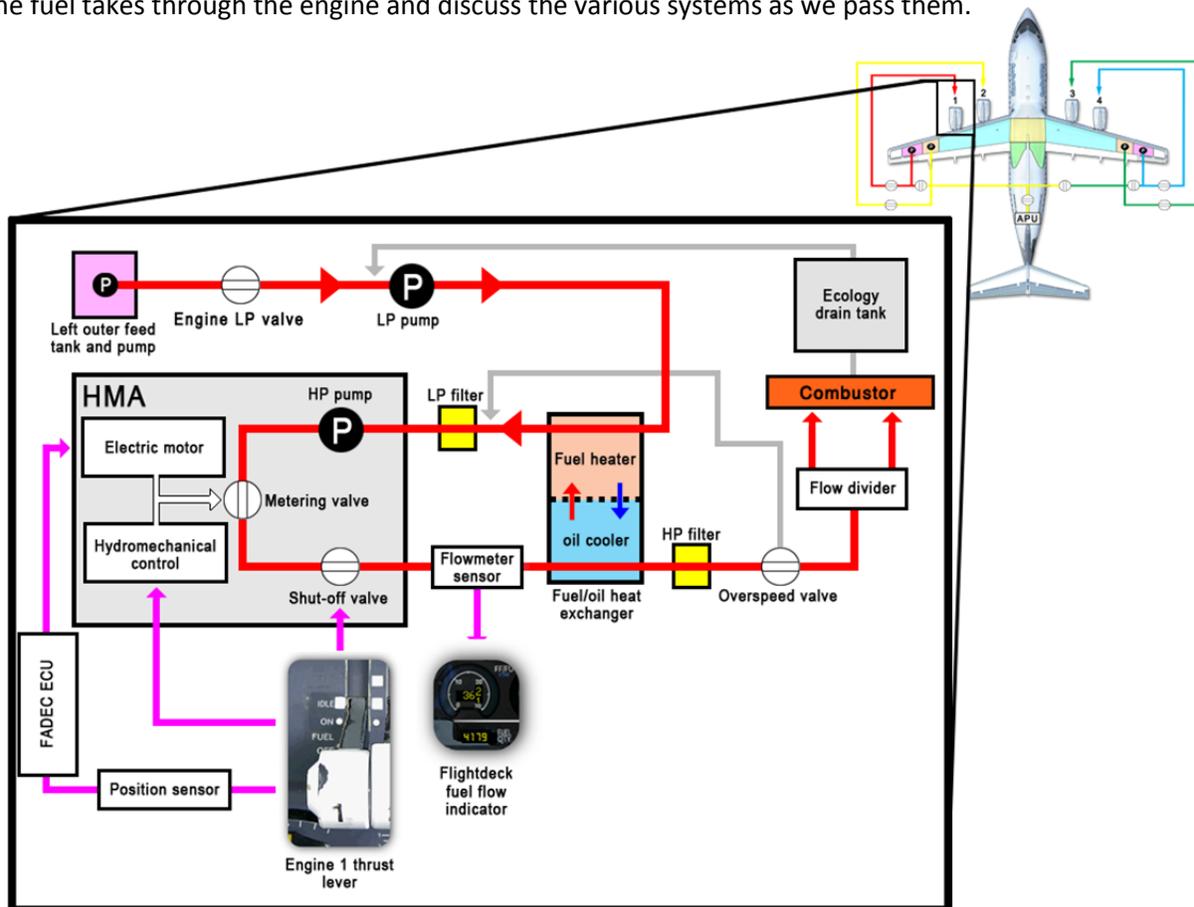
Figure 31: Zoomed-in schematic of the outer left engine's fuel supply system. The red line is the path the fuel takes through the engine, passing all important engine related systems in the process.

When fuel arrives at the engine's fuel inlet, it has already gone through the LP valve. This valve will close when the associated engine fire handle has been pulled (not simulated). There is no other way to get this valve to shut, and there is no indicator in the cockpit to show the position of the valve except for the fire handle being pulled out or not.

The fuel goes through a LP pump next. This pump pumps the fuel through the fuel pre-heater, where, obviously, the fuel gets pre-heated. This will cause the fuel's pressure to rise. The way the fuel is heated is quite clever, mind you. Next to the fuel pre-heater, there is the oil cooler. Warm oil flows in here to cool down. It cools down by "giving" its warmth to the fuel. This way not only the oil is cooled, but the fuel is warmed in the process.

The fuel goes next through a LP filter, to filter out any muck that might have gotten in the fuel. The indicator FILTER CLOGGED will illuminate if the LP filter is clogged. At that point, fuel will not go through the filter anymore, but will use a bypass. In the bypass a pressure switch is activated when the pressure increases. If it is activated, it will cause the FILTER CLOGGED light to illuminate.

Afterwards, the fuel enters the Hydro-Mechanical Assembly (HMA). The HMA is the most important part of the engine's fuel supply, since it helps governing fuel flow into the engine and has a substantial part to play during engine start.

The Hydro-Mechanical Assembly: regulating fuel flow

The HMA consists of a HP pump, and the Hydro-Mechanical Unit (HMU). It's very important to keep the HMA and HMU apart. *HMA* is the *complete hydro-mechanical system*, while the *HMU* is only a *sub-system*. That said, the HMU is the most important part of the HMA. It comprises a hydro-mechinical control unit, a flow metering valve, a thrust lever position sensor, an electrical motor and a shut-off valve. Note that the HMA as depicted in Figure 31 is therefore not fully accurate, for the thrust lever position sensor has been depicted outside of the HMA although it is parts of the HMA. This was done due to space limitations in the figure. For the full HMU schematic, please refer to Figure 32.

The HMA's only purpose is to adjust the fuel flow into the combustor. It does this by opening and clos-ing the metering valve in just the right amount to allow a certain amount of fuel into the duct leading to the combustor's fuel inlet. The amount to open or close the valve is controlled by the relevant thrust lever on the flight deck (for the metering valve in Figure 31 this would be thrust lever 1, since Figure 31 depicts the fuel system of engine 1). Moving the thrust lever forward will send a command to open the metering valve, moving it aft will send a command to close it.

Just by sending a command, the metering valve is not going to open or close however, since the valve itself does not have any means to deal with that. Instead there are two systems in place in the HMA that can perform this task:
− The *FADEC ECU* is an indirect method to adjust the valve's position.
− The *hydro-mechanical control* is a direct method to adjust the valve's position.

The difference between the two systems is how they are connected to both the thrust levers and the metering valve, and as the above list hints, it's all about being connected directly or indirectly. Figure 31 also hints towards this. Let's not get ahead of ourselves, though. We will explore both systems now and we will compare them in the process.

FADEC is a term that has already been introduced before, but to recap it stands for *Full Authority Digi-tal Engine Control*. ECU stands for *Engine Control Unit*. It is a system that intelligently and electronically adjusts fuel flow to the combustor, depending on the thrust lever position. What's so intelligent about this? It's the fact that it deals with restrictions. No matter what you do with the thrust levers, the FADEC will never allow the engines to operate above or below their current capability (current, mean-ing at that present moment during the flight). Obviously it does this by ignoring certain thrust levers commands to open or close the metering valve that could overspeed the engine or cause a flameout. Because it may ignore certain thrust lever commands it is called "full authority": it has *full authority over the fuel flow* to the engines and thus the engine's RPM and delivered thrust, to the point where it may ignore the pilot's input if it brings the engine performance in danger. As such, it is not merely a "slave" of the thrust lever, doing whatever it commands without checking whether the engine can ac-tually comply with that thrust lever setting.

It is this full authority versus slave mentality where the FADEC ECU and hydro-mechanical control are so fundamentally different. While the FADEC ECU has full authority over the eventual engine thrust delivered, the HMU has that not. Instead, the HMU does whatever the thrust lever commands it to do. As such, it is *not* full authority: the *pilot* has full authority in this case!

Seeing that there are two systems in place that basically do the same thing, although one has additional functions, how do they manage to work alongside each other without conflicting? The answer is that they simply don't work alongside each other, but separately. I admit that this doesn't sound very logical, but bare with me. See Figure 32.
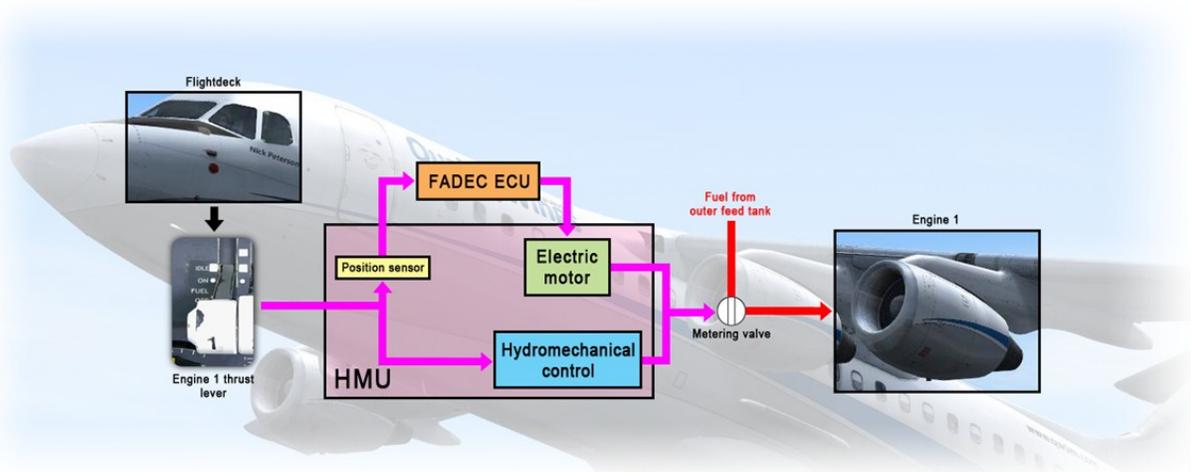
Figure 32: HMU schematic for metering valve operation.

The Figure above shows the two routes that exist all the way from the flightdeck, where the thrust levels are moved, to the eventual amount of fuel that reaches the combustor.

- Route 1 is the indirect route: within the HMU, a position sensor senses the position of the thrust lever, and sends this information electrically to the FADEC ECU. The FADEC ECU then determines the amount to open or close the metering valve, and sends an electric command to an electric motor. This electric motor is in direct contact with the metering valve, and will adjust its position according to the FADEC ECU's command.

- The second route is the direct route. Here there is no electrical intervention, and the thrust lever position directly affects a hydro-mechanical control system. The hydro-mechanical control then adjusts the position of the metering valve according to the command given by the thrust lever.

The trick is that the second route is a back-up route. As long as the FADEC ECU works, it sends a signal to the hydro-mechanical unit that shuts it down. When the FADEC ECU is inoperative, this signal is lost, and in turn the hydro-mechanical control turns on, assuming the FADEC ECU's function.

Thanks to this system, fuel gets dosed, and always just the right amount of fuel is allowed to enter into the combustor. In the HMA there still is one more component however: a shut-off valve. The shut-off valve is a valve that does what the name says: it completely shuts off fuel access to the engines. The valve is solely controlled by the engine's thrust lever. Put the thrust lever in the OFF detent, and the valve will close.

Outside the HMA we find some final components in the engine's fuel path. The first thing is a engine fuel flow meter. This meter senses the amount of flow coming through, and thus going to the engine. The meter reports to the fuel flow gauge in the cockpit, of which there are four: one for each engine.

The fuel also passes through the oil cooler and another filter (high pressure this time) followed by an overspeed valve. The overspeed valve leaks fuel out of the engine's fuel path in the case of an engine overspeed condition. In order to get the engine back on track, fuel is leaked out of this final path, so that less fuel reaches the engine's combustor. As a result, the RPM of the engine drops because less fuel is burned, and the engine goes out of the overspeed condition. The leaked fuel is returned to the low pressure filter.

Before the fuel goes into the combustor, it passes flow divider. The flow divider divides the fuel into two separate flows. Both flows enter the combustor, where it gets burned. Not everything always gets burned however (think of engine shutdown, when some excess fuel still remains "in the pipes" and gets to the combustor too late, and thus is not burned). The fuel that does not get burned gets into the *ecology drain tank*, so names because collecting the unburned fuel is an act of fuel conservation and recycling, for the collected fuel is returned to an earlier part of the engine's fuel path, namely before the low pressure pump.

We have now gone over all of the most relevant system and components that keep the engine running; that make sure fuel gets into the engine and get there in the correct dose. There is more the engine systems – all kinds of gauges and levers on the throttle quadrant and main instrument panel – but these will be discussed elsewhere. Note that for functional descriptions of the engine systems you will be referred back to this chapter.

System summary

The engines are what drive everything on board of the aircraft. They power the electrical system, provide air for the air conditioning systems and provide hydraulic power to the hydraulic system. To keep the engines running lots of subsystems are active that regulate temperature, fuel supply and oil supply. The main component that keeps the engine from truly shutting down however, is the fuel supply.

The engines built of up a series of compressors (low and high-pressure) and turbines (low and high pressure). The low-pressure compressors and turbine are on one shaft, and the high-pressure ones are on one shaft. Much like with the APU, air flows into the compressors, where it is pressurized. It then flows through the combustors, where the fuel that is ignited gives it kinetic energy with which it can drive the turbines. Because the turbines and compressors are all on the same shafts, the rotation of the turbine also rotates the compressors, making the engine a self-governing entity. The only thing that can stop the engine is the fuel supply: when this is cut off, the engine will stop.

Because the fuel supply is so essential, it is no surprise that the systems governing fuel supply are so extensive. Both systems are located or related to the HMA: the Hydro-Mechanical Assembly. The HMA is called after the HMU: the Hydro-Mechanical Unit. However, the HMU is only one of two systems that govern fuel supply, the first being the FADEC ECU, or Full Authority Digital Engine Control Electronic Control Unit. The FADEC ECU is a electronic version of the HMU, the latter being mechanical. The FADEC ECU has a very important benefit however: because of its electronic nature, it can keep track of operating limitations, thus protecting the engines from pilot errors in thrust setting, which could cause engine overspeeds or flame-outs.

The FADEC ECU, while active, sends a signal to the HMU that shuts it off. If the FADEC ECU fails however, this prohibiting signal is lost, and the HMU will start operating, thus providing a backup system for the FADEC ECU. Instead of electronic control, the HMU will provide mechanical control. In essence it does the same thing as the FADEC ECU, except that it does not keep track of limitations. In this scenario, not the engine systems have full authority, but the pilot has full authority.

ICE PROTECTION

Q FEEL HTR FAIL
> *Annunciator indicating that the Q-pot pressure head heater has failed*

AUX PITOT HTR FAIL
> *Annunciator indicating that the auxiliary pitot heater has failed*

L VANE HTR FAIL
> *Annunciator indicating that the left Angle of Attack vane heater has failed*

R VANE HTR FAIL
> *Annunciator indicating that the right Angle of Airflow vane heater has failed*

L SCREEN HI TEMP
> *Annunciator light signifying that the temperature of the associated A or B screen is higher than normal*

R SCREEN HI TEMP
> *Annunciator light signifying that the temperature of the associated A or B screen is higher than normal*

L PITOT HTR FAIL
> *Annunciator indicating that the left pitot heater has failed*

R PITOT HTR FAIL
> *Annunciator indicating that the right pitot heater has failed*

L/R SCREEN HEAT ON/OFF switch
> *Enables the crew to turn ON or OFF the heaters for the left and right cockpit windows*

AUX & L VANE ON/OFF switch
> *Turns the left Angle of Airflow vane heater and auxiliary pitot heater ON or OFF*

L PITOT HTR ON/OFF switch
> *Turns the left pitot heater ON or OFF*

R PITOT & R VANE HTR ON/OFF switch
> *Turns the right pitot heater and right Angle of Airflow vane heater ON or OFF*

L OUTER VALVE
> *Annunciator light indicating that the left outer wing anti-ice valve is not in the position by the OUTER WING ANTI-ICE ON/OFF switch*

L INNER VALVE
> *Annunciator light indicating that the left inner wing anti-ice valve is not in the position by the INNER WING DE-ICE ON/OFF switch*

TAIL HI TEMP

Annunciator light indicating that there is a leak of hot air into the fin leading edge

TAIL VALVE 1

Annunciator light indicating that tail anti-ice valve 1 is not in the position by the TAIL ANTI-ICE ON/OFF switch

R OUTER VALVE

Annunciator light indicating that the right outer wing anti-ice valve is not in the position by the OUTER WING ANTI-ICE ON/OFF switch

R INNER VALVE

Annunciator light indicating that the right inner wing anti-ice valve is not in the position by the INNER WING DE-ICE ON/OFF switch

AIR LO TEMP

Annunciator light indicating that the air supply from one or more of the engines is not hot enough for adequate ice protection

TAIL VALVE 2

Annunciator light indicating that tail anti-ice valve 2 is not in the position by the TAIL ANTI-ICE ON/OFF switch

OUTER WING ANTI-ICE ON/OFF switch

Turns the anti-ice for the outer part of each wing ON or OFF

INNER WING DE-ICE ON/OFF switch

Turns the anti-ice for the inner part of each wing ON or OFF

TAIL ANTI-ICE ON/OFF switch

Turns tail anti-ice ON or OFF

Engine Ice Protection Subpanel

INTAKE 1/2/3/4 HI PRESS

Annunciation light indicating that a higher than normal pressure was detected in the engine's associated anti-ice valve (1, 2, 3 and/or 4)

INTAKE 1/2/3/4 LO PRESS

Annunciation light indicating that a lower than normal pressure was detected in the engine's associated anti-ice valve (1, 2, 3 and/or 4)

ENG 1/2/3/4 VLV NOT SHUT

Annunciation light indicating that the engine's associated anti-ice valve is not shut

ENG 1/2/3/4 ANT-ICE switches

Four switches turn ON or OFF the engine's associated anti-ice system. At ON the engine's associated anti-ice valve is opened, at OFF it is closed

HOW TO USE

Contrary to many of the overhead subpanels, the ice protection subpanel is not a set-and-forget system in its entirety, rather an "on demand" type of system. A selection of the switches can be set and should be left alone for the entirety of the flight, such as all air data sensor heaters, but others, such as airframe anti-ice switches, will only have to be set to ON when flying through a moist environment at below-zero degrees Celsius temperatures. So when do you set these switches?

On the ground – flight deck safety checklist
>   *On the ground you set **engine anti-ice** ON before engine start. The rest stays OFF*

On the ground – after start
-   *After engine start you may set engine anti-ice as required. If in icing conditions, leave it ON. Otherwise turns it OFF.*
-   *Turn all heaters ON. These are the L and R SCREEN HEAT, AYX & L VANE, L PITOT HTR and R PITOT & R VANE switches*

In flight
>   *The heaters are kept ON during the remainder of the flight until engine shutdown. Engine anti-ice and all airframe anti-ice can be turned ON whenever it is necessary and turned OFF whenever it stops being necessary. It is necessary in icing conditions: moist environments with a temperature below zero degrees Celsius. Think of clouds at high flight levels, for example*

Landing
>   *For landing, make sure to **turn OFF** airframe and tail anti-ice using the respective switches*

After landing
>   *After landing, the **engine anti-ice** can be set to ON or OFF depending on outside conditions. For icing conditions, set them to ON. You may also set them to ON if the temperature is below 10 degrees Celsius, but it's not necessary, otherwise, set them to OFF*

Shutdown
>   *When you shut the plane down at the gate, do the following and make sure that:*
-   *All airframe anti-ice/de-ice are turned OFF*
-   *Engine anti-ice is set to ON*
-   *All heaters are turned OFF*

SYSTEM DESCRIPTION

Ice Protection system overview

The ice protection systems on boards the Avro RJ and BAe-146 series are scattered over two subpanels. The first one controls airframe anti-ice, including the air data sensors (pitot probes, etcetera), the second controls engine anti-ice. This is done using hot air, hot oil, both supplied by the engines, and electrical heaters. Hot air is used for most of the airframe anti-ice systems, such as to protect the wing leading edges, tail-plane leading edges and engine intakes. Hot oil is used solely to protect the engine's fan spinner from ice accretion. Electrical heaters protect a wide variety of components, such as the A and B windscreens, the flight data sensors (pitot probes, TAT probes, etcetera), the elevator trim circuit and the rudder trim circuit. Figure 33 gives an overview of all the protected components of the aircraft's exterior. Note that the air data sensors were not signified due to their small size.
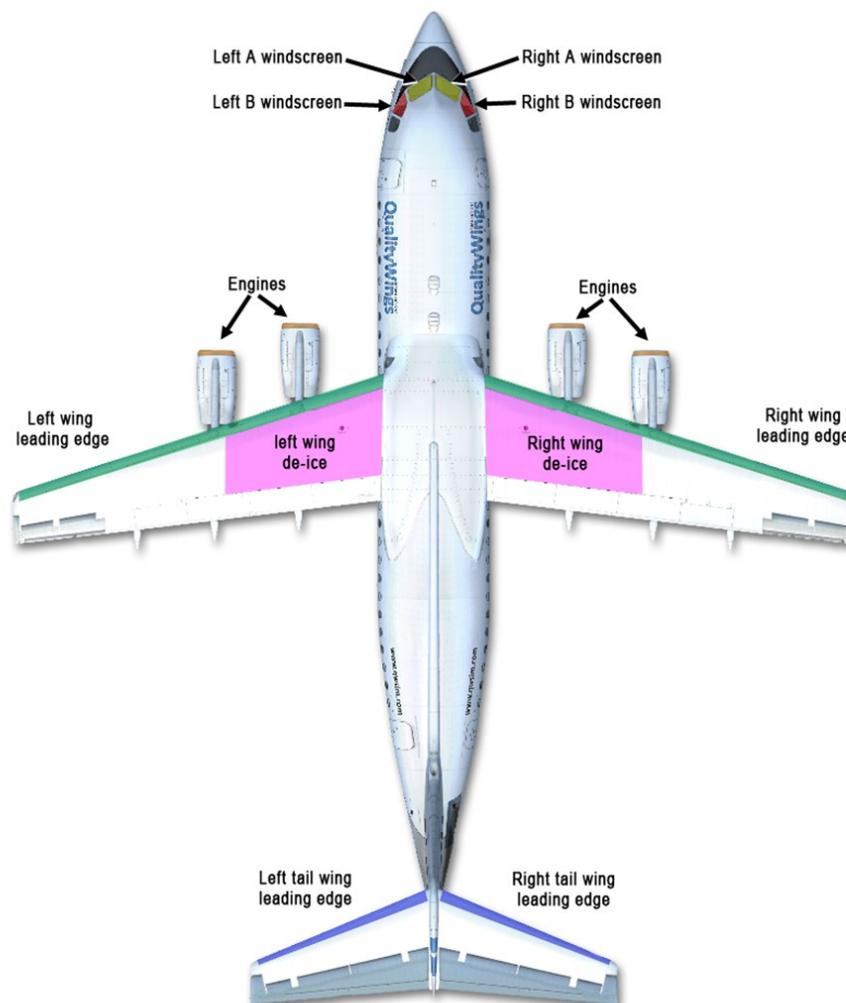
Figure 33: Protected places of airframe anti-ice, engine anti-ice and windscreen heaters

Wing and tail ice protection

Wing and tail anti-ice/de-ice operates using hot air leached from the engines. The hot air is guided to key points on the wing and tail-plane leading edges. Valves, controlled by switches on the overhead panel control the access of the hot air to the wing and tail-plane leading edges. See Figure 34.
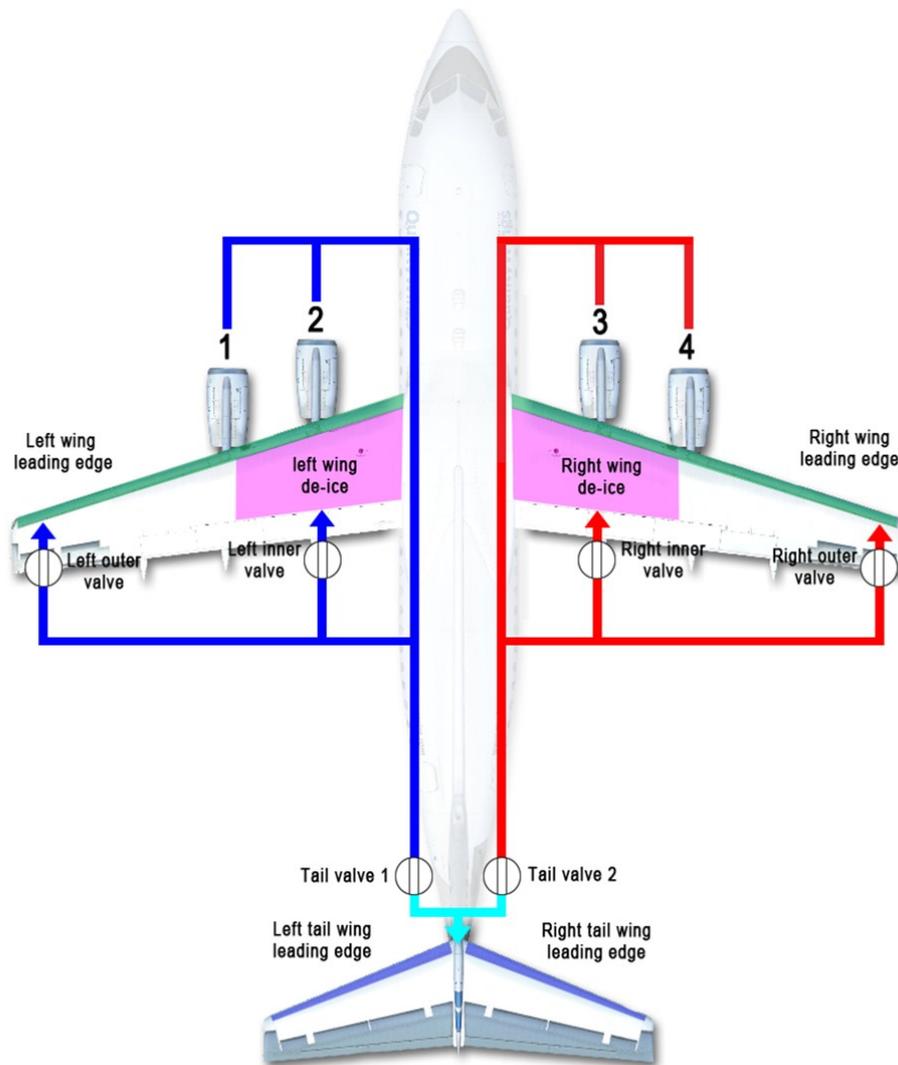
Figure 34: Wing and tail anti-ice and de-ice

In the Figure above you can see how the hot air supply is channeled to the wings and tail. There is a separation between the left and right ice protection system, only coming together at the tail for tail-plane leading edge ice protection. Otherwise everything is separate. The two engines' hot air supply is combined within the left and right ice protection systems.

Each airframe anti-ice/de-ice switch on the overhead panel controls two valves:
–   The inner wing de-ice switch controls a left inner and right inner valves that allow the hot air supply access to the magenta areas in Figure 34
–   The outer wing anti-ice switch controls the left outer and right outer valves that allow the hot air supply access to the green areas in Figure 34
–   The tail anti-ice switch controls two valves in the tail (valve 1 and valve 2) that allow the hot air supply access the blue areas in Figure 34

There is an annunciator light for all of these valves on the ice protection subpanel. When they illuminate, it means that the valve is not in the position commanded by the switch. Thus they can light up when the valve has failed, but also when the valve is in transit to each new position.

Engine anti-ice protection

The engine components that are protection against ice are the engine intake, the air splitter and the low-pressure compressor inlet guide vanes. To protect these parts, hot air is leached from the engine's high-pressure compressor and guided via pipelines to these parts.
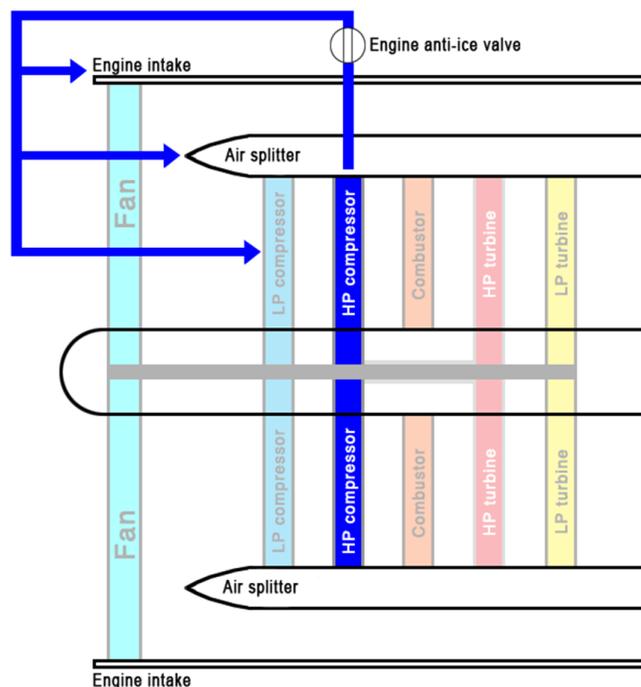
Figure 35: Engine anti-ice

Figure 35 gives an overview of engine anti-ice. The air is taken out of the high-pressure compressor and guided to various components that are likely to ice. These are the engine intake, the air splitter and low-pressure compressor. A single valve, controlled by the respective engine anti-ice switch on the engine's ice-protection subpanel, allows the hot air access to these engine components. If the pressure of the air is not sufficient for engine anti-ice, a INTAKE LO PRESS annunciator will illuminate. If the pressure is too high, signifying that the air pressure regulator has failed, a INTAKE HI PRESS annunciator will illuminate. The ENG VLV NOT SHUT annunciator will light for its respective engine when a certain pressure threshold downstream of the anti-ice valve has been crossed. This is an indication that the valve has opened successfully. There is no warning if the valves have not opened successfully.

—INTENTIONALLY LEFT BLANK—

AIR SUPPLY
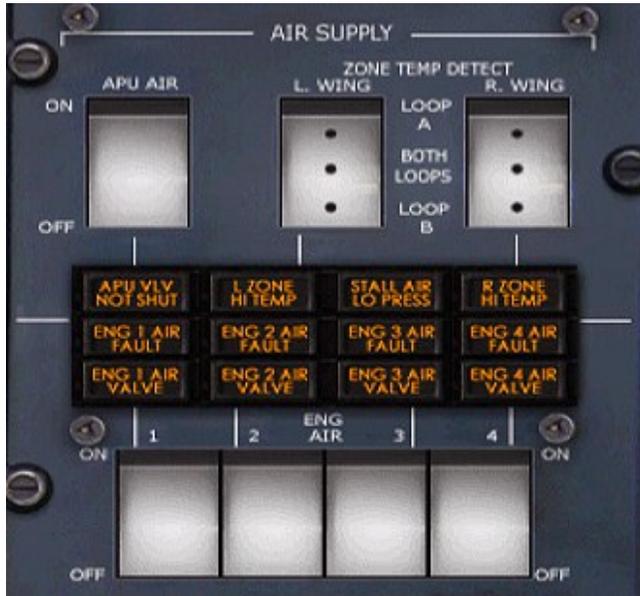
APU AIR switch

Allows the crew to turn ON or OFF air supplied by the APU

ZONE TEMP DETECT L/R WING switch

Allows the crew to select which loops are to be used by the associated zone overheat detection system
(not simulated)

APU VLV NOT SHUT

Annunciator indicating that the APU air valve is not shut, even though the APU is OFF or the APU AIR switch it set to OFF

L ZONE HI TEMP

Annunciator indicating that a hot air leak has been detected in the left zone (not simulated)

STALL AIR LO PRESS

Annunciator indicating that the stall air reservoir pressure is under 25 psi

R ZONE HI TEMP

Annunciator indicating that a hot air leak has been detected in the right zone (not simulated)

ENG 1/2/3/4 AIR FAULT

Annunciators indicating that there is a fault in the associated engine pylon's bleed system

ENG 1/2/3/4 AIR VALVE

Annunciators indicating that the associated engine's air valve is not in the position commanded by the switch

HOW TO USE

You don't really meddle with the air supply system during most of the flight.

On the ground

> You may use APU AIR by starting the APU and setting the APU AIR switch to ON for air conditioning until engine start. At engine start, all packs, APU and engine AIR valves should be closed

After start

> After successful start of the engines, you may set the ENG AIR switches to ON. If the APU is still running and you'll keep it running, you can also use APU AIR instead of ENG AIR

After takeoff

> If APU AIR is still used after takeoff, set ENG AIR switches to ON, then set APU AIR switch to OFF if you wish, but this is not mandatory for short flights (20 minutes flight time). If you already have the ENG AIR switches set to ON, you are all set and have to do nothing

After landing

> As you taxi to the gate after landing, it is recommended to start the APU, and then set the APU AIR switch to ON. Afterwards set the ENG AIR switches to OFF

SYSTEM DESCRIPTION

Air Supply system overview

The air supply system provides the aircraft's pneumatic services with the hot air required. The air is leached from the four engine high-pressure compressors and the APU compressor.

The air supply system is divided into two different channels. The left channel is supplied by engines 1 and 2. The right channel is supplied by engines 3 and 4. One can also divide the air supply system in an *upstream* and a *downstream* part. The upstream air supply system supplies engine anti-ice and hydraulic reservoirs. The downstream part provides the rest of the air supply system with air, including both air conditioning packs and wing anti-ice.

Schematic of the Air Supply system

First and foremost, the air supply system is a supply system, as the name suggests. It doesn't do a lot except getting air to the aircraft's pneumatic services. As such there is nothing complicated about it, such as with the fuel and electrical systems. There are no busbars, no pumps, no reservoirs, mainly four engines, air valves, and that's it. See Figure 73 for a schematic.
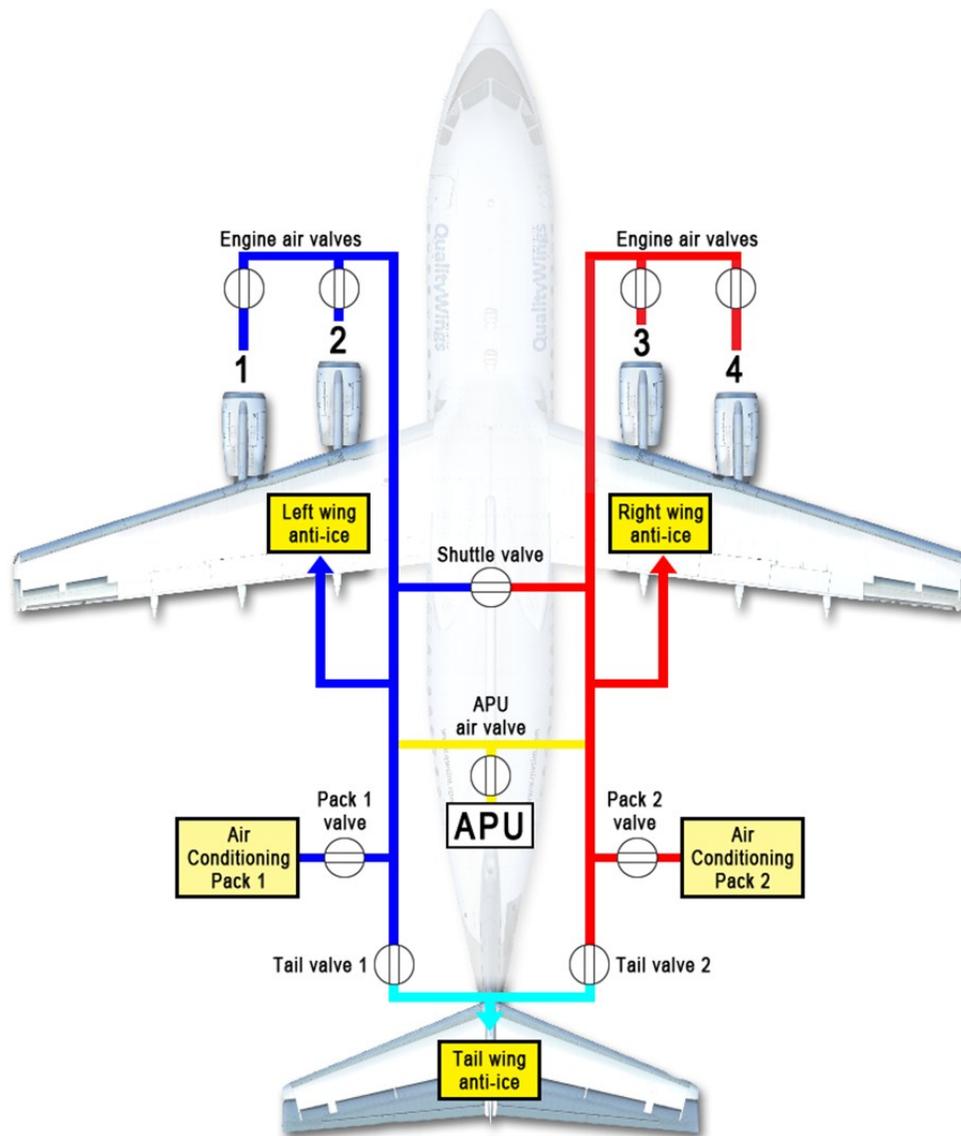
Figure 36: The BAe series air supply system

The APU and engines supply the air from their compressors (the engines from the high-pressure compressors). The hot air goes through an air valve that can be controlled from the flight deck: set the ENG AIR switches to ON to open the valves, and to OFF to shut them. The valve may not be fully opened, though. Besides it acting as a shut-off valve, it also controls the air's pressure. ENG AIR FAULT annunciators may light up in one or more of the following circumstances:

- If the valve fails to successfully regulate air pressure and the air pressure becomes too high. It will be automatically shut in this case.

- If the temperature of the air is too high

- If the air pressure is too low and airframe anti-ice is ON

An ENG AIR VALVE annunciator is provided for each engine. If a valve is not in the commanded position (because it has failed or is in transit to the new position), these annunciators will illuminate. A similar annunciator is available for the APU: APU VLV NOT SHUT. It will illuminate under the same conditions for the APU, as the ENG AIR VALVE annunciators will for their respective engine air valve.

A heat exchanger (pre-cooler) follows the air valve. The hot air from the high-pressure compressor flows through the heat exchanger, where it is cooled. It is cooled by air from the engine fan that flows through the engine's bypass duct. The cooled air afterwards flows to the many services around the air-craft, such as the wing anti-ice and de-ice system, air conditioning system and pressurization system. For information on these systems and how the air is used to provide the associated services, please see the mentioned page numbers. The APU does not have a heat exchanger, for the hot air from the APU is not nearly as hot as the air from the engine's high-pressure compressor and as such it doesn't have to be cooled.

AIR CONDITIONING

FLT DECK TEMP CTRL AUTO/MAN switch

Allows the crew to set the flight deck temperature control to automatic or manual mode.
Manual mode is not simulated

FLT DECK TEMP CTRL WARM/COOL switch

Allows the crew to manually set a warmer or cooler temperature. This is not simulated.

FLT DECK FAN switch

Allows the crew to switch the flight deck fan ON or OFF

CABIN FAN switch

Allows the crew to switch the cabin fan ON or OFF

CABIN TEMP CTRL WARM/COOL switch

Allows the crew to manually set a warmer or cooler temperature. This is not simulated

CABIN TEMP CTRL AUTO/MAN switch

Allows the crew to set the cabin temperature control to automatic or manual mode.
Manual mode is not simulated

Flight deck temperature rotary selector

When the air conditioning system is on AUTO mode, this knob allows the crew to select a temperature for the flight deck

DUCT TEMP gauge

Shows the flight deck's air delivery duct temperature

CABIN TEMP gauge

Gauge showing the temperature in the forward cabin

Cabin DUCT TEMP gauge

Shows the cabin's air delivery duct temperature

Cabin temperature rotary selector

When the air conditioning system is on AUTO mode, this knob allows the crew to select a temperature for the flight deck

AVIONICS FAN OFF

Annunciator indicating that the air flow at the avionics fan inlet is low

PACK 1/2 HI TEMP

Annunciator indicating that the associated pack's delivery duct has reached excessively high temperatures

REAR BAY HI TEMP

Annunciator indicating that the temperature in the air conditioning bay is too high

EFIS/IRS FAN FAIL

Annunciator indicating that one or more of the EFIS or IRS fans has failed

CAU 1/2 HI TEMP

Annunciator indicating that the cold air unit has reached excessively high temperatures

RECIRC VALVE

Annunciator indicating that the recirculation valve is not in the position commanded by the CABIN AIR switch. At RECIRC the valve is open, at FRESH it is shut

PACK 1/2 VALVE

Annunciators indicating that the associated valves are not in the position commanded by the PACK 1/2 ON/OFF switches

RAM AIR VALVE

Annunciator indicating that the valve is not in the position commanded by the RAM AIR switch

CABIN AIR RECIRC/FRESH switch

Allows the crew to change the cabin air mode to FRESH or RECIRC. At FRESH, cabin air is partly fresh, while at RECIRC, part of the cabin air is recirculated

PACK 1/2 ON OFF switch

These switches allow the crew to turn the associated air conditioning packs ON or OFF

RAM AIR SHUT/OPEN switch

Allows the crew to SHUT or OPEN the RAM AIR valve

HOW TO USE

The air conditioning system is a system you'll want to have on during most of the flight since it ventilates the plane. However, because of the air requirements, make sure the air supplier can cope with the extra load by making sure that the APU or engine shave stabilized before turning on the various services.

Air conditioning is something that can either be required or not while on the ground, and whether the packs should be ON or OFF is something you'll have to evaluate yourself. If it is a hot day, you will want to switch them ON after engine start, otherwise you can leave them off. Note however that after take-off they have to be ON for cabin pressurization!

On the ground - Flightdeck safety checklist
- *PACK 1 and 2 switches set to OFF*
- *RAM AIR switch set to SHUT*
- *APU AIR set to ON, but make sure APU EGT has stabilized first! It is normal to wait at least two minutes before turning on APU AIR*
- *CABIN FAN and FLT DECK FAN switches can be set as you wish*
- *If APU EGT has stabilized and APU AIR is ON, you may set PACK 1 and PACK 2 switches to ON also*
- *The CABIN AIR switch can be set as you wish. Normal procedure is to use RECIRC on the ground up until 10 minutes before the passengers arrive, thereafter use FRESH. Use FRESH again after landing*
- *AVIONICS FAN switch set to ON*

On the ground - Before start
- *CABIN FAN should be set to ON if not already done so*

On the ground - Starting
- *PACK 1 and 2 switches should be set to OFF*

On the ground - After start
- *Set the PACK 1 and 2 switches to ON for an air-conditioned takeoff. Make sure that either ENG AIR or APU AIR is set to ON first!*
- *If you use ENG AIR, set CABIN AIR to RECIRC*

After takeoff
- *While previously you could choose yourself whether to set them to ON or OFF, the PACK 1 and 2 switches must be ON now so that the cabin is pressurized*

After landing
- *Set CABIN AIR to RECIRC*

SYSTEM DESCRIPTION

The air conditioning system ventilates, pressurizes and controls the temperature of the cabin and flight deck. The pressurization system and its associated subpanel are not discussed in this specific chapter. . For a schematic of the air conditioning system, see Figure 37.

The air conditioning system is supplied by air from the air supply system, and its main components are the two air conditioning packs, termed pack 1 and 2. These are located at the back of the plane, in the air conditioning bay. Pack 1 is supplied by the left wing air supply system or the APU, and pack 2 is supplied by the right wing air supply system or APU.

On the flight deck, the two packs carry different names instead of pack 1 and pack 2. Switches are labels with the following names:

- Pack 1 is referred to as "flight deck" and it supplies the flight deck and the cabin
- Pack 2 is referred to as "cabin" and it supplies just the cabin

Setting their respective switches to ON activates the two packs. The PACK 1 and 2 valves will then open and allow air from the air supply systems to enter the packs. These will then provide air to the flight deck and cabin air distribution system, which is a collection of pipes running along the walls and floor of the aircraft through which air is distributed around multiple locations in the cabin and flight deck.

A manual and automatic mode is provided, but the manual mode is not simulated. In automatic control, the crew can set a temperature using the rotary selector on both sides of the air conditioning panel. The left one controls pack 1/flight deck temperature, the right one controls pack 2/cabin temperature. On the gauges between these two selector knobs, one can see the temperatures of the packs' delivery ducts and the cabin temperature.

The pack's associated annunciators warn the crew of too high temperatures via the PACK HI TEMP annunciators. The CAU HI TEMP annunciators illuminate when the cold air units, which get hot in the process of cooling the air for use in the air conditioning system, have too high temperatures. The PACK VALVE annunciators will illuminate when the pack valves are not in the position commanded by the pack switches.

Two fan switches are fitted. The fan switches supply the air fans in the cabin and flight deck with air. Set them to ON to turn them on. An avionics fan switch is provided to turn the avionics fan ON or OFF. If the airflow at the avionics fan's inlet is too low, the annunciator AVIONICS FAN OFF will illuminate. The avionics fan cools the avionics by providing a cold airflow over the avionics. Two IRS and two EFIS fans are also fitted, that cool the IRS and EFIS units.

A RAM AIR switch is installed to control the RAM AIR VALVE. The associated annunciator indicates whether the valve is in the commanded position, being open or shut. When opened, RAM air can supply the air distribution in the flight deck and cabin.
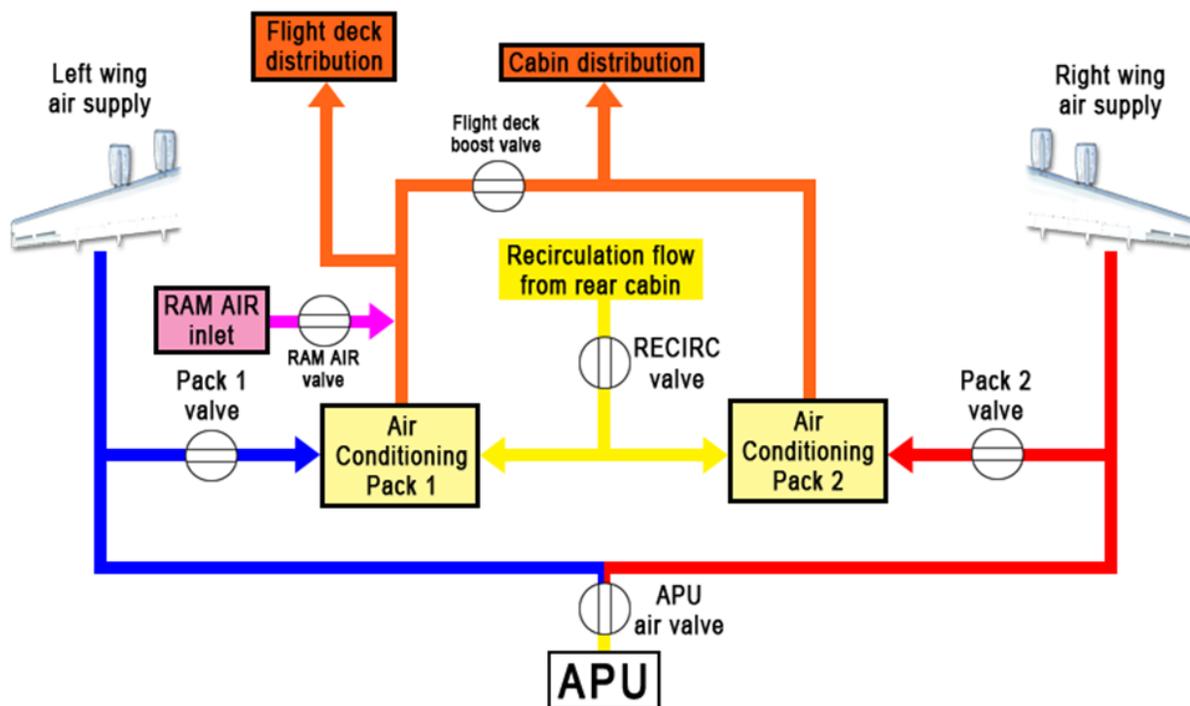
Figure 37: The air conditioning system.

PRESSURIZATION (Avro RJ)

LCD display showing:
1. Cabin rate [Feet Per Minute]
2. Cabin pressure difference [PSI]
3. Cabin altitude or selected Landing Altitude (temporarily) [feet]

LDG ALT knob
Allows the crew to set the landing altitude. Even on automatic mode, setting the landing altitude is mandatory

AUTO/MAN push button
Allows the crew to take manual control or set automatic control of the pressurization system. Manual mode is not simulated

Outflow valve selector
Enables the crew to set how the outflow valves behave. At NORMAL, the outflow valves are set to get the commanded cabin rate or cabin altitude. DITCH and DUMP are not simulated.

Outflow valves full open
These annunciators show if any of the two valves (primary and secondary) are fully opened

HOW TO USE

The pressurization system modeled in the Qualitywings Avro RJ-series is the fully automatic variant. As such, you have to do close to nothing to get it to operate.
The one and only thing you need to do is set the **landing altitude** using the LDG ALT knob.
You can do this after takeoff. For the rest you do not have to touch this subpanel at all during any stage of the flight.
Just make sure that the two air conditioning pack switches are set to ON after takeoff. Without the packs being active, no pressurization is possible. To understand why, please read "Operating principle of the pressurization system".

SYSTEM DESCRIPTION

Introduction to the pressurization system

The pressurization system's goal is to achieve comfortable air pressure during all stages of flight, no matter if the airplane flies at 100 feet or 35000 feet, or whether it's climbing or descending. The BAe 146/Avro RJ series has always known two types of pressurization systems. One is semi-automatic, the other is fully automatic.

For the QualityWings BAe-146 series we have chosen to simulate the fully automatic pressurization system. It gets its name of course from the fact that it is fully automatic. The crew has to set the landing altitude, but otherwise everything works automatically. There is a manual mode, but this is not simulated besides being able to manually set landing altitude. This can be done using the LDG ALT knob.

The little LCD display is your main portal into what the pressurization system is doing. It typically displays three numbers:

- *The first line shows the cabin rate in feet per minute*

- *The second line shows cabin differential pressure in psi*

- *The third line shows cabin altitude in feet. When you manually alter the landing altitude, this number will change into the landing altitude that you are currently setting. If you wait momentarily, the cabin altitude will be redisplayed until you change the cabin altitude again*

Operating principle of the pressurization system

What does it mean "to pressurize"? Pressurizing means that a certain amount of substance has been introduced into a confined space. When talking about pressurizing, one usually refers to air. Air locks in space ships are "depressurized" when an astronaut goes for a spacewalk, but they are pressurized again once the astronaut wants to get back inside. The critical thing is that exactly the right amount of air has to be introduced for successful pressurization. What is the exact amount of air? It is that amount of air that is comfortable for us human beings to live in. This is what the pressurization system does: it makes sure that at all times the amount of air in the cabin and flight deck is exactly the right amount for us to feel comfortable.

The way it does this is by managing the amount of air that leaves the cabin. When the pressure is too high, it makes more air go out of the cabin, and when the pressure is too low, less air gets out of the cabin. It can do this by manipulating two outflow valves: the primary and secondary valves. The problem you might see here now is, if the pressurization system makes air leave the cabin, how does it introduce *new* air? For if you keep getting rid of air, you'll end up having a pressure that is too low, or the air will be satisfied with carbon dioxide, effectively killing the passengers. There has to be a way in which fresh air is introduced.

As you might expect now, the pressurization system is completely dependent on two other systems: the air supply system and the air conditioning system. As was said, the pressurization system only gets rid of air, thus regulating the amount of air in the cabin, but it relies on the air conditioning system to supply *new* air. This is also why it's terribly important to turn the air conditioning packs ON after take-off if not ON already; without the packs supplying the cabin and flight deck air distribution systems with air, no new air will be supplied to the cabin and flight deck. As such, no pressurization will be possible. So by extension the pressurization system is also dependent on the air supply system, because the air conditioning system receives its air from the air supply system. As an aside, the outflow valves that are controlled by the pressurization system are controlled pneumatically using a shuttle valve. The air required for this service is also supplied by the air supply system. See Figure 77 for a schematic.
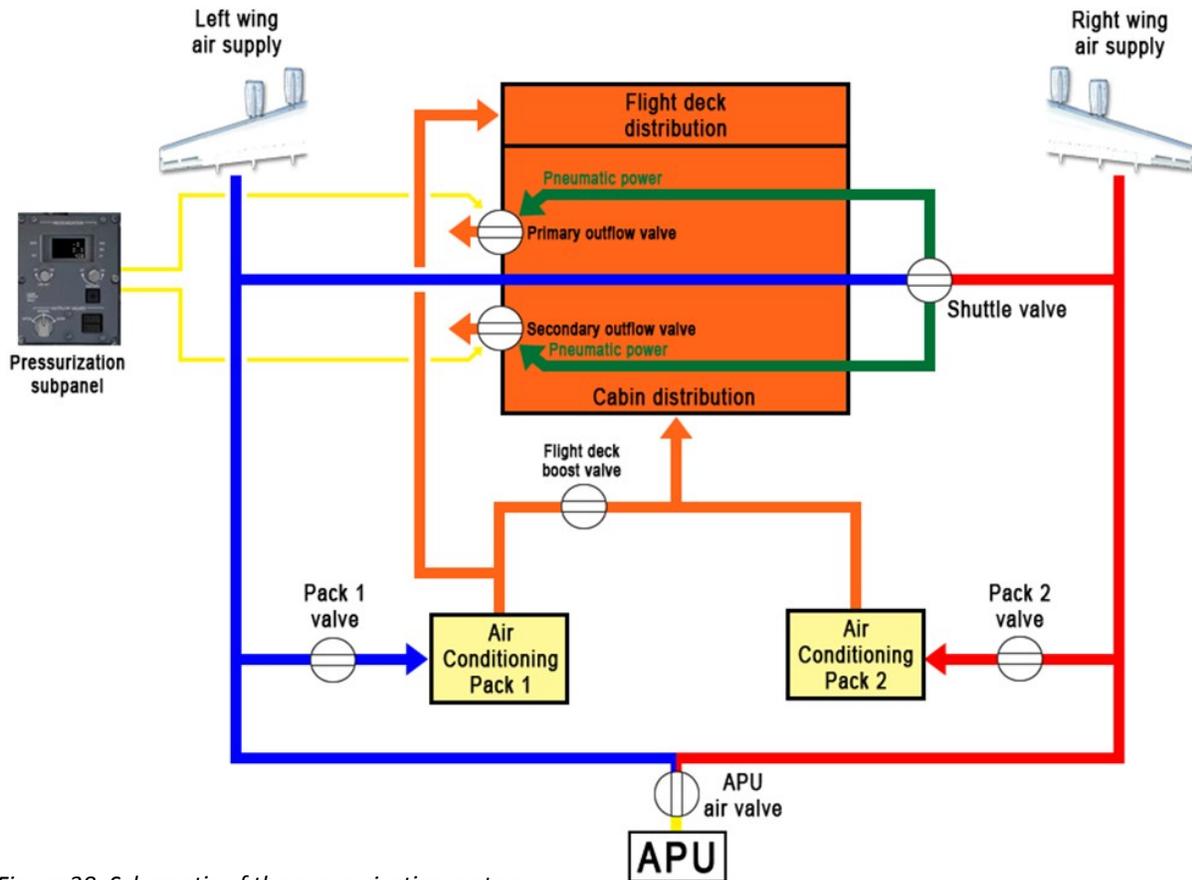
Figure 38: Schematic of the pressurization system

In Figure 38 you can see a schematic of the pressurization system. It is immediately apparent that there is a chain of systems in place here: the air supply system, followed by the air conditioning system, followed by the pressurization system. To recap what can be seen in this schematic:

1. *The air supply system supplies the two air conditioning packs, as well as the shuttle valve*

2. *The air conditioning packs provide conditioned air for the air distribution system, which distributes air around the cabin and flight deck*

3. *By means of two outflow valves, the air introduced by the air conditioning's air distribution system is let out of the cabin and flight deck*

4. *By regulating these two valves, a certain amount of air can be let out of the cabin and flight deck, thus keeping air pressure on a certain level, and thus keeping the cabin pressurized*

5. *The valves are pneumatically controlled: a shuttle valve opens or closes access to these valves. When it opens, the air supply system has direct access to the valves.*

6. *The pressurization subpanel seen in Figure 76 electronically controls how much the outflow valves should be opened or shut*

PRESSURIZATION (BAe146)

Discharge Valve Gauges
> Showing the position of the two discharge – or outflow valves.

ALT knob
> *Allows the crew to set the target cabin altitude.*

AUTO/MAN push button
> *Allows the crew to take manual control or set automatic control of the pressurization system. Manual mode is not simulated*

Outflow valve selector
> *Enables the crew to set how the outflow valves behave. At NORMAL, the outflow valves are set to get the commanded cabin rate or cabin altitude. DITCH and DUMP are not simulated.*

HOW TO USE

The pressurization system modeled in the Qualitywings BAe146-series is the semi-automatic variant.

The one and only thing you need to do is set the **target cabin altitude** using the ALT knob.
Rotate it, so that the needle points to your cruise altitude on the inner scale. The outer scale displays the according target cabin altitude, to which the cabin pressure will be regulated.
When descending to your destination, set the target cabin altitude to 0 again.

MAIN INSTRUMENT PANEL

The Main Instrument Panel in the Virtual Cockpit

Main Instrument Panel in the 2D Panel

The main instrument panel is where you'll spend most of your time. It is filled with screens and annunciators and for good reason: this panel is in the pilot's immediate field of view and as such is the best place to stick in all indicators for vital information. This information comes in the graphical format of the EADI and EHSI, but also in a more cryptic format, namely that of the caution and warning annunciators on the Central Warning Panel and Central Status panel. In this chapter all the gauges, screens and annunciators will be discussed and when necessary you'll find references to relevant system chapters.

The main instrument panel is built up of four "subpanels". While this division is not as outspoken as the subpanels on the overhead for example, each of them has a specialty of its own. So while they are not visually separated, they are functionally somewhat separated. See Figure 79.

The Figure above shows this separation in functionality. You will have noticed that in this figure only three areas have been signified, and not four. This is because part of the main instrument panel is not displayed: the missing part contains the first/officer's flight instruments. Would this part be displayed, it would have been "part four". As such, we can summarize the various panels as having these functionalities:

1. Captain's flight instrument (Left Instrument Panel)

2. Flight guidance controls and warning lights. This panel actually has its own name: Mode Control Panel (MCP)

3. Engine instruments, master warning panel and miscellaneous levers and buttons

As such there are four somewhat distinct functional groups of gauges, annunciators and levers/buttons/switches on the main instrument panel. We will discuss them in the other numbered.

1. CAPTAIN'S FLIGHT INSTRUMENTS (LEFT INSTRUMENT PANEL)

As the name suggests, the captain's flight instruments portion of the main instrument panel contains all displays, gauges and indications relevant for safe flight on the captain's side of the main instrument panel. What we find here are all gauges that give situational awareness, such as an airspeed indicator, altimeter, ADI, HSI, DBI and TCAS displays, among other things. Although probably obvious to the initiated, it is still worthwhile noting that most of these instruments have a counterpart on the right instrument panel. As such, all the gauges described here are the "left" versions of those gauges, as opposed the "right" versions of these gauges placed on the right (first officer's) instrument panel.

Primary Flight Display (Avro RJ)

Providing situational awareness and most relevant flight information, the primary flight display (PFD) is one of the most important gauges the pilot has. The PFD is also often referred to as the Electronic Attitude Display Indicator (EADI). The PFD is powered by the AC Busses, which makes it necessary to have either External Power, the APU Generator or one of the Engine Generators provide power. If your PFD remains black, even though electrical power is sufficient, make sure you have the "AVIONICS MASTER" buttons on the Overhead Panel in the "ON" Position.

The main areas of the PFD are:
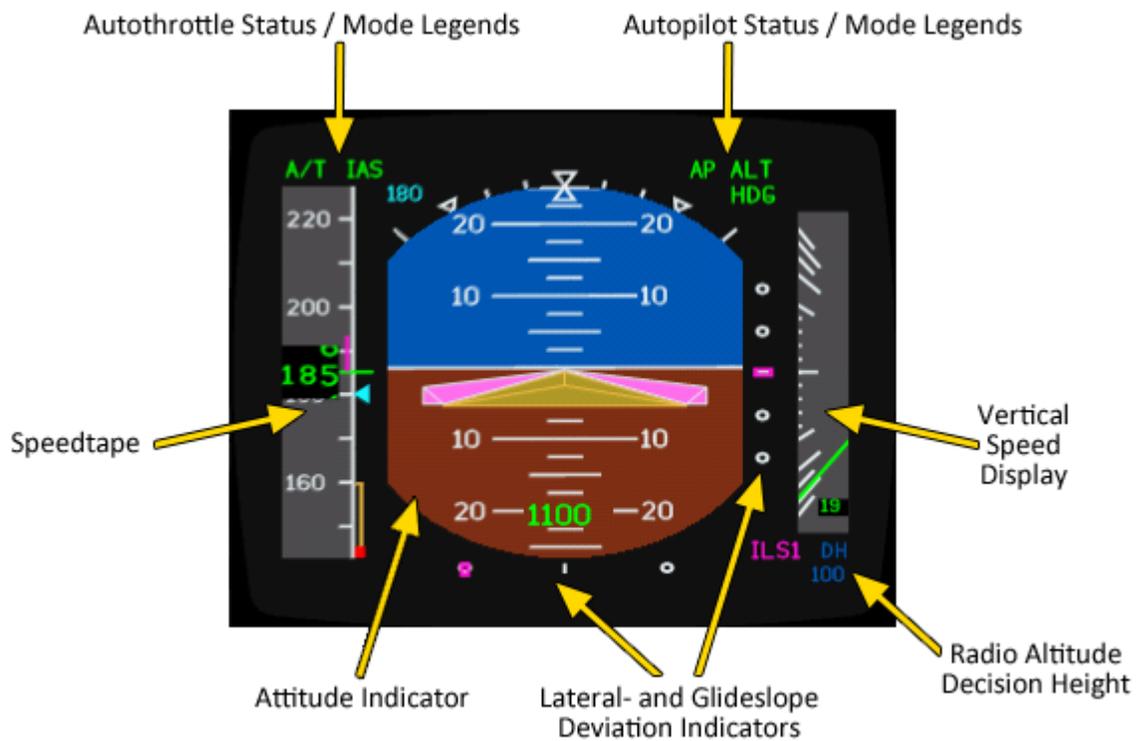
TIP: If your Attitude Indicator shows blank, your IRS is not aligned.

Attitude Indicator Symbology
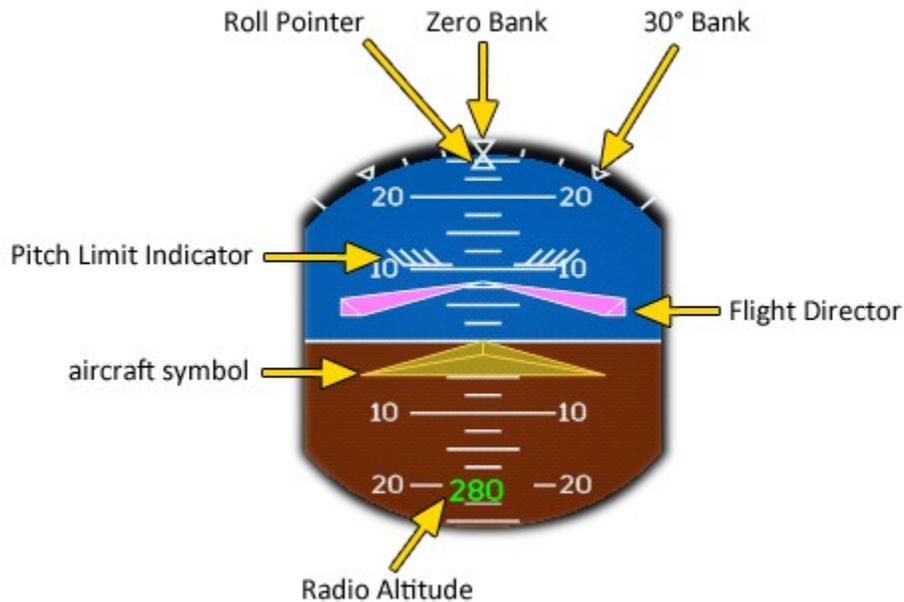
Do note that there are two types of aircraft- and flight director symbols available. Alternatively to the single cue you can select a split cue type either on the fly from your QualityWings ControlPanel or by adding "FlightDirectorType=0" to your qw146.cfg. For more information on that, check out the "Config Options" Section of this manual.

Vertical Speed Display Symbology

A needle to the right of the Attitude Indicator indicates the vertical speed on a scale in hundreds of feet.

At a rate of climb or descent of more than 200ft/min, a digital readout is shown next to the needle.

At an excess of 6000ft/min, the digital readout turns yellow.
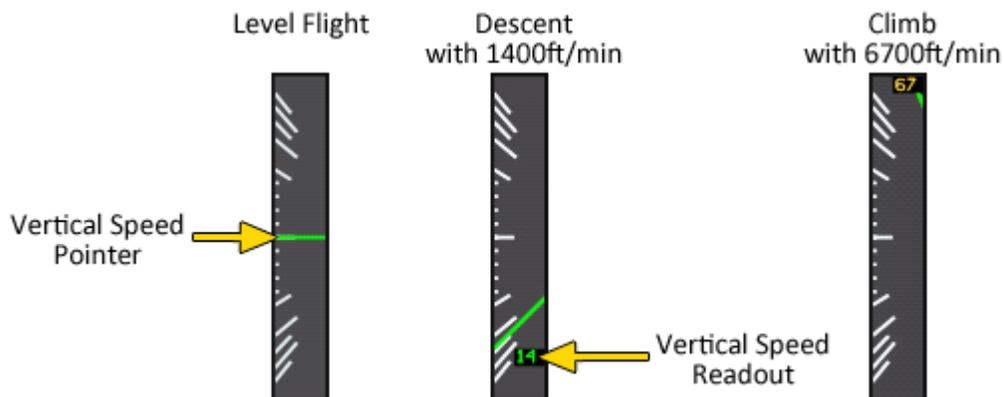
Speedtape Symbology
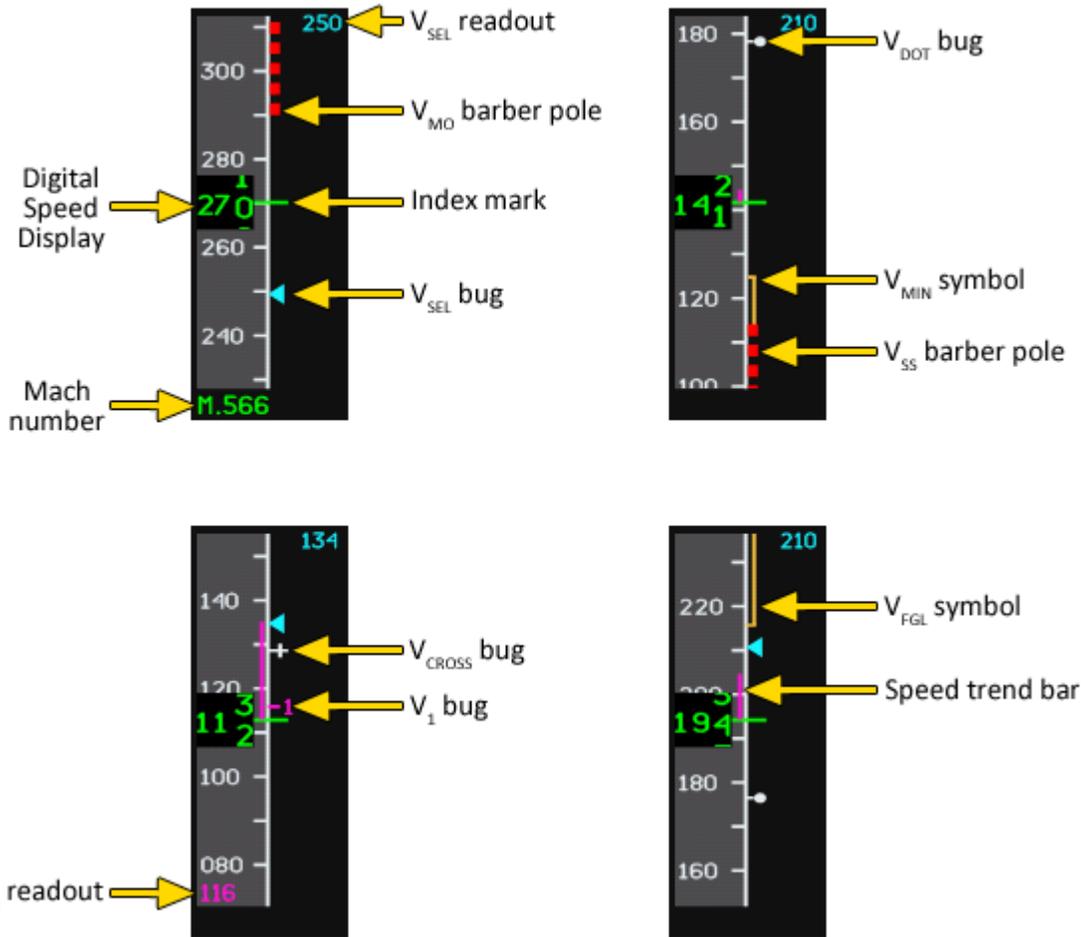
Explanation of the Speeds / Speedbugs:

V_{SEL}   Selected Speed on the MCP

V_{MO}   Maximum Operating Speed

V_{MIN}   Minimum Operating Speed

V_{SS}   Stall Speed

V_{FGL}   Maximum Speed with Flaps not retracted

V_1   Take Off Decision Speed. After passing V_1, the take off can't be aborted any more.

V_{DOT}   Usually equals V_{FTO}. Final Take Off Speed. Make sure to retract your flaps completely when passing this speed.

V_{CROSS}   Usually equals V_R. Rotation Speed. This is the speed to begin your rotation and lift the nose wheel off the ground.

The appropriate speed bugs are being set manually via the Thrust Rating Panel (TRP).

Lateral– and Glideslope Deviation Symbology

The Lateral– and Glideslope Deviation Indicators inform the pilot of the airplane's lateral position relative to a VOR or Localizer Radial and the vertical position relative to an ILS Glideslope. They're positioned below and to the right of the Attitude Indicator.

Unless we're talking about a backcourse approach, the indicators command towards the signal.

In other words, *the pointers always show you the direction, you have to fly to.*

Glideslope Deviation
(too low)

ILS / VOR Source Legend

Lateral Deviation
(left of Localiser)
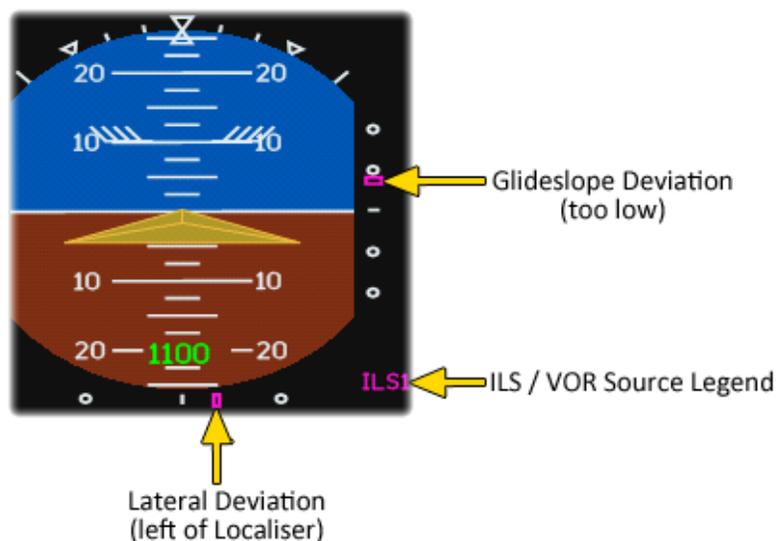
Lateral Deviation Indicator Symbology:

 ILS Localiser

 VOR Radial

 LNAV Track

The figure above shows the three different kinds of lateral Deviation Indicators.

In order for them to show on the PFD, the "CRS" Knob on the EFIS Control Panel below the FMS needs to be in the "V/L" Position for ILS and VOR, or in "LNAV" for the LNAV Track Deviation Indicator.

Radio Altitude Decision Height Symbology

The Radio Altitude is shown in green digits on the lower (orange) portion of the Attitude Indicator. It only appears when the Airplane is below 2500ft. On descent through the Decision Altitude, the Radio Altitude is displayed in yellow until the airplane passes through 10ft.

The Decision Height is shown below the Vertical Speed Display on the PFD.

The Decision Height is only shown if:
- the airplane is on the ground and below 2500ft
- for three seconds if a change is made to the Decision Height

When approaching the Decision Height, it gets highlighted the following way:
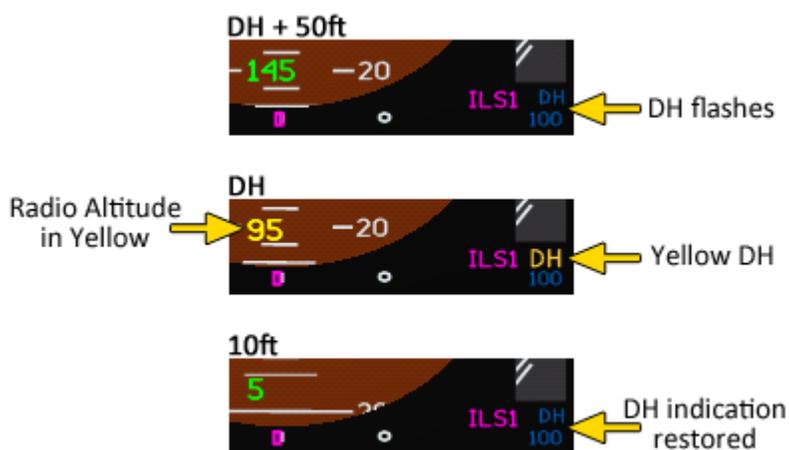
Autothrottle Status and Mode Symbology

The Autothrottle Status and Mode is shown above the Speedtape on the PFD. Generally we distinguish between two color codes.

WHITE The Status or Mode is armed

GREEN The Status or Mode is active

If a Status or Mode is disengaged, it doesn't show at all.

Possible Autothrottle Status legends are:

`A/T`   Autothrottle armed

`A/T`   Autothrottle active

On the ground, only TOGA MAX or TOGA REDU can be selected via the TRP. These always show in white, unless the Autothrottle is armed and the "THRUST" button gets pressed. That activates the TOGA Mode and shows a green "A/T TO MAX" or "A/T TO REDU". The Autothrottle then automatically drives the thrust levers to the commanded N1 rating.

Possible Autothrottle Mode legends are:

`TO MAX`	TOGA MAX rating is selected
`A/T TO MAX`	TOGA MAX rating is armed
`A/T TO MAX`	Autothrottle is controlling to the maximum Take Off Thrust rating
`TO REDU`	TOGA REDU rating is selected
`A/T TO REDU`	TOGA REDU rating is armed
`A/T TO REDU`	Autothrottle is controlling to the reduced Take Off Thrust rating
`A/T MCT`	Autothrottle is controlling to the Maximum Continuous Thrust rating
`A/T CLB MAX`	Autothrottle is controlling to the Maximum Climb Thrust rating
`A/T CLB NORM`	Autothrottle is controlling to the Normal Climb Thrust rating
`A/T IAS`	Autothrottle is controlling the Speed.
`A/T MACH`	Autothrottle is controlling the Mach number

Autopilot / Flightdirector Status and Mode Symbology

The Autopilot Status and Mode is shown in the upper right corner of the PFD. Again, we distinguish between two color codes.

WHITE The Status or Mode is armed

GREEN The Status or Mode is active

If a Status or Mode is disengaged, it doesn't show at all.

Possible Autopilot Status legends are:

`FD`   Flightdirector engaged

`AP`   Autopilot engaged (regardless of Flightdirector)

Engaging the Autopilot or Flightdirector, will put it in the default modes, which is Alt Hold and Heading Hold. The Modes are shown right of the Status legends. The upper line shows vertical, the lower line lateral modes. Armed modes are shown in white next to the active mode.

Possible vertical mode legends are:

`VS`   Vertical Speed

`ALT`   Altitude Hold

`ACQ`   Altitude Acquire

`IAS`   Level Change—IAS on pitch

`MACH`   Level Change—MACH on pitch

`GS*`   ILS Glideslope capture and track

`FLR`   Autoland landing flare

`GRND`   Autoland nose lower

`TO`   Pitch Take Off

`PITCH`   BAe146-300: Pitch mode

Possible lateral mode legends are:

`ROLL`   Heading Hold or rollout after Autoland—BAe146-300: Bank mode

`HDG`   Heading Select

`VOR1`   VOR 1 capture and track

`LOC*`   ILS Localizer capture and track

`BLC1`   ILS Backcourse capture and track

`ALN`   Autoland runway align manoeuver

Primary Flight Display (BAe146)

The PFD on the BAe146-300 is similar to the one of the Avro RJ and will thus not be explained in detail. The only difference is the lack of the speedtape and vertical speed indication. Autopilot modes and the aircraft attitude are indicated in the same manner as in the Avro RJ.
On the BAe146-100 and -200, an analogue Attitude Display Indicator (ADI) is installed.
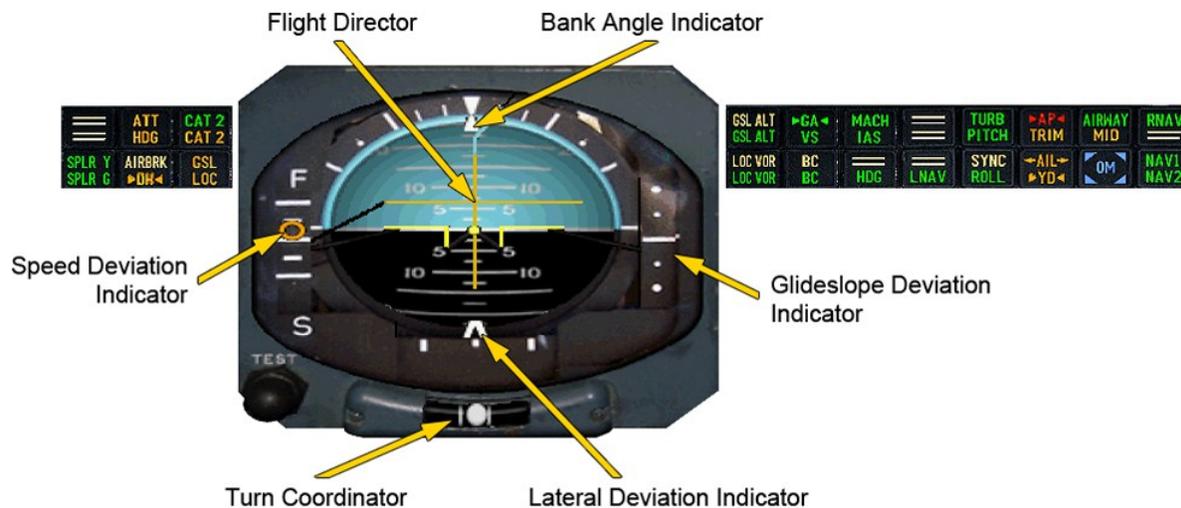
The speed deviation indicator shows the deviation in reference to the selected speed on the airspeed indicator (yellow triangle bug).

Active flight director and autopilot modes are indicated by two rows of flight mode annunciators located next to the ADI.

Navigation Display (ND)

While the PFD only provides situational awareness for the airplane's attitude and speed, the Navigation Display gives the pilot exact information about the direction the plane is moving and where it currently is. In other words, the PFD shows you HOW, and the ND shows you WHERE the plane flies. In general there are four formats in which the ND can show the data. Let's start with the Rose and Arc Format. The Information displayed in these two formats is the same, so we'll just look at the Rose Format and see what we find there. The information shown on the ND can be controlled by the EFIS Control Panel, which is located below the FMS.

Rose Format
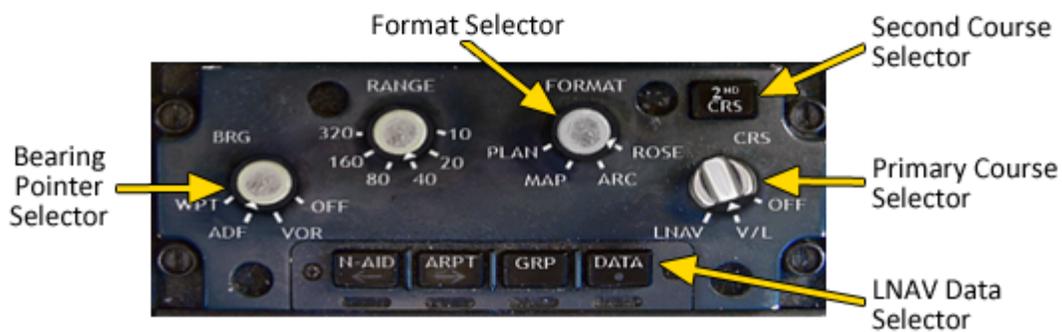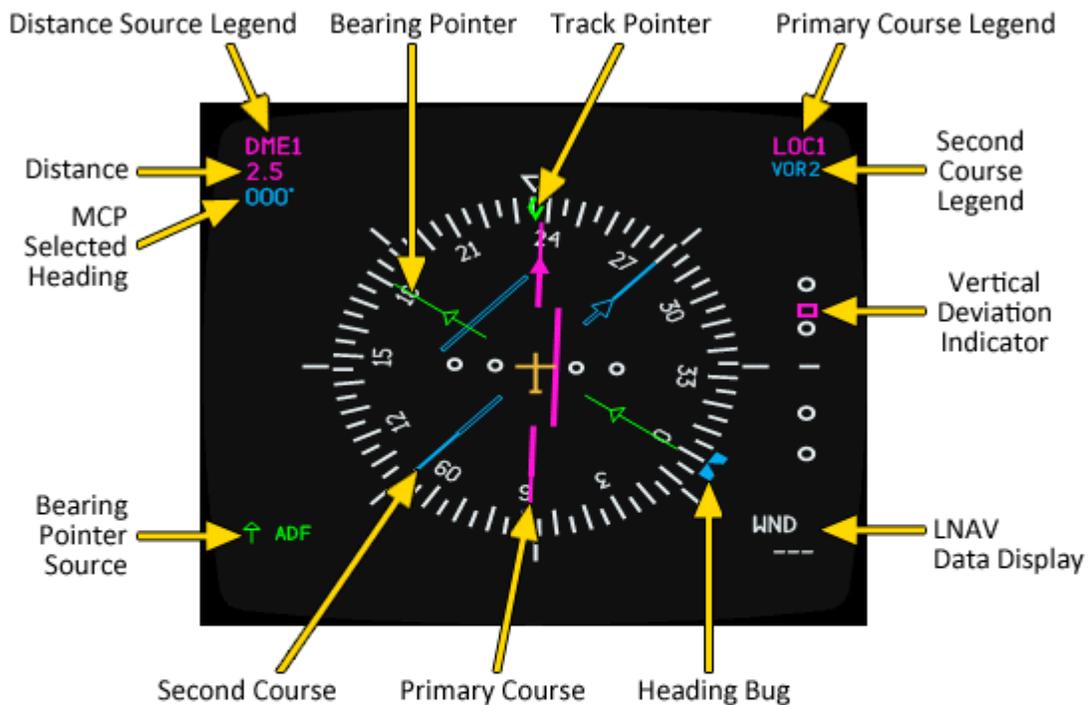
Primary Course

The Primary Course Indicator can be selected to OFF, to a VOR/ILS radial or an LNAV waypoint via the Primary Course Selector on the EFIS Control Panel.

If set to V/L, a VOR/ILS radial gets shown. The *Pointer* is shown in green (VOR) or magenta (ILS) and points to the course selected next to the NAV1 box on the MCP. A *Scale* with a *Beam Bar* shows the airplane's deviation to the radial.

If LNAV is selected on the Primary Course Selector, the *Pointer* shows in white and is oriented in the heading between your last and your next waypoint.
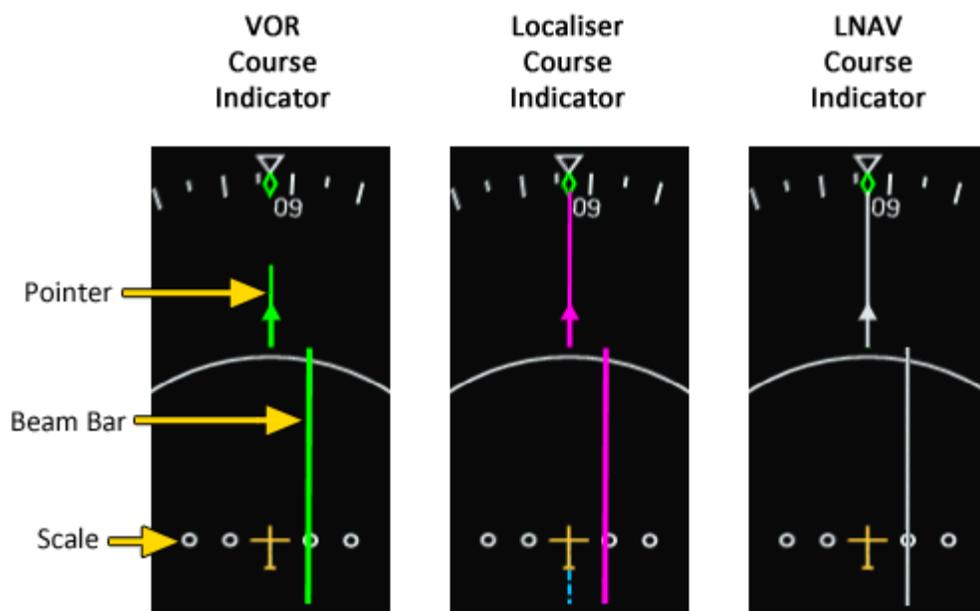
Just as the Deviation Indicators on the PFD, the Beam Bar shows the radial or track relative to your airplane. In the specific case shown above, the plane is offset to the left, meaning you have to fly to the right in order to be on track.

Primary Course Distance

The Distance is shown in the upper left corner of the ND. In V/L mode, it shows the distance to the tuned radio beacon (DME1). In LNAV mode, the distance to the next waypoint is shown.

Second Course

The second course source gets toggled via the Second Course Selector. It's only possible to select sources, which are NOT already selected as Primary Course. For instance if you have VOR1 selected as your Primary Course, the Second Course Source can only be VOR2 or LNAV. The principle of the Second Course Indicator is the same as for the Primary Course with the only difference being that the Second Course always shows in blue.

Bearing Pointer

There is a green Bearing Pointer, which shows the direction to a selected VOR, NDB, or LNAV Waypoint. The Bearing Pointer is always shown in green and the Bearing Pointer Source is displayed in the lower left corner on the ND. To select a Bearing Pointer Source, simply rotate the Bearing Pointer Selector on the EFIS Control Panel to the desired Source. This can be either OFF, VOR, ADF or WPT. Do note that in this product it is not possible to display VOR2 or ADF2 on the ND.

Vertical Deviation Indicator

Just like the Glideslope Indicator on the PFD, the Vertical Deviation Indicator shows the aircraft's position relative to the vertical path. Additionally to the Glideslope, the ND can also display a VNAV Deviation. With the pointer on the center line, the aircraft is on the descent path. The top and bottom scale markings indicate a deviation of 200ft. Just as the Glideslope indicator, it commands the direction to go. So if the pointer is above the center line, the descent rate has to be decreased in order to 'climb' back to the descent path.
Do note that the VNAV Vertical Deviation Indicator can only be displayed, when the Primary Course Indicator is set to LNAV.
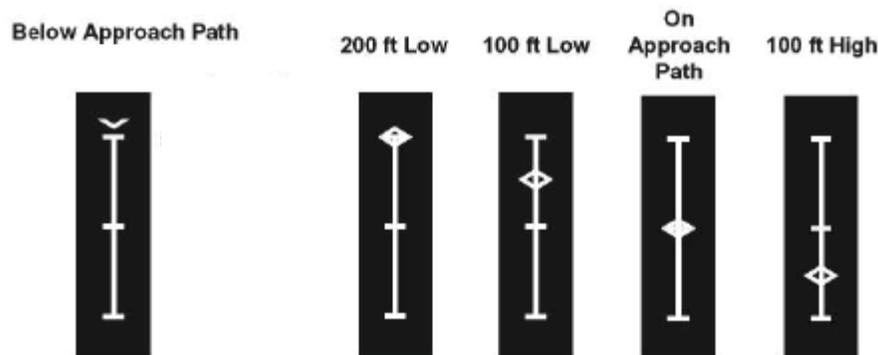
LNAV Data Display

Various types of information can be shown in the lower right corner of the ND. Subsequent clicks of the LNAV Data Selector on the EFIS Control Panel toggle through the following information:

WND Wind Vector
GSPD Groundspeed
DIST Distance to Active Waypoint
ETA Estimated Time of Arrival at the Active Waypoint

Heading Bug and Track Pointer

The Heading Bug marks the MCP selected Heading on the Compass Rose. The Track Pointer shows the current path the aircraft really flies. Due to wind this can significantly differ from the aircraft's actual heading. For example if the wind comes from the left, the track pointer is offset to the right of the current heading.

Map Format
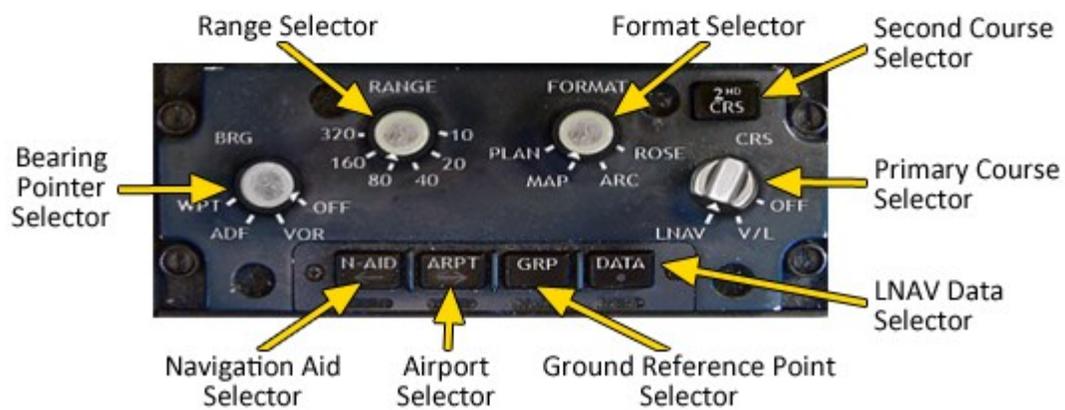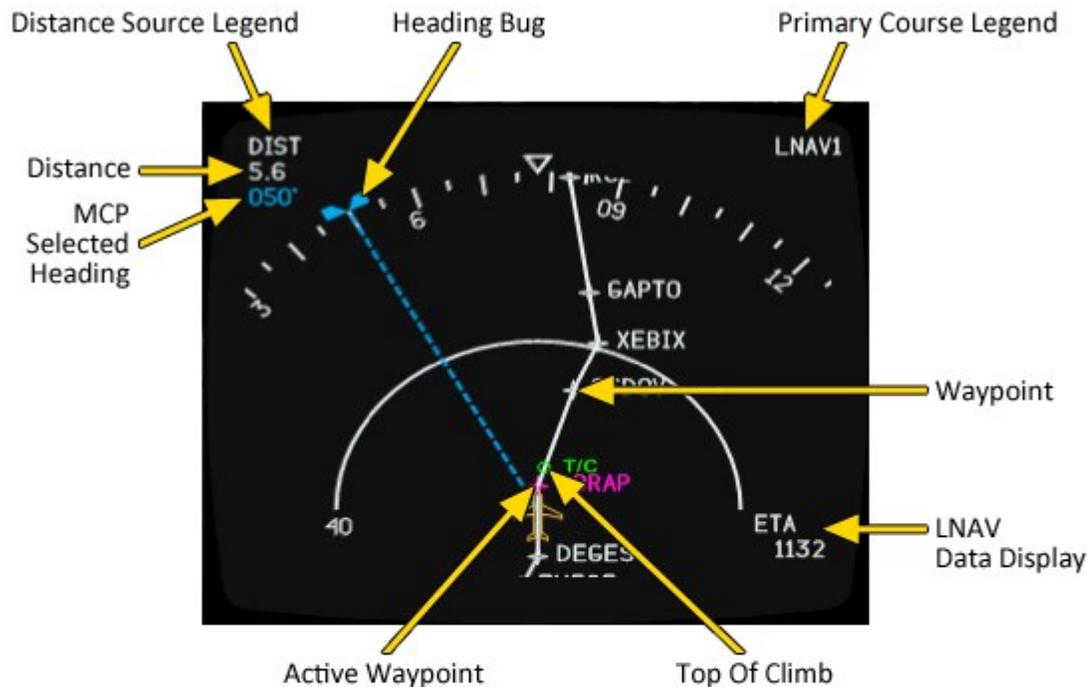
At the first glance, the Map Format might look the same as the Arc Format. However, there is a significant difference in the way LNAV navigation is displayed. Instead of a Pointer and a Beam Bar, the programmed route with all the waypoints gets shown. You can see it in form of a white track line reaching from waypoint to waypoint. This format gives you the best overview of the route ahead of you. Only the items which are not present in the Rose and Arc Modes will be explained.

Waypoints

The Active Waypoint is always shown in magenta and your next point to overfly on your route. The Distance shown in the upper left corner refers to this waypoint. All other waypoints are shown in white.

Top Of Climb / Top Of Descent

The Top Of Climb is shown as a small green circle with "T/C" next to it. This is the projected point where your aircraft reaches the Cruise Altitude. In addition to the Top Of Climb, the Top Of Descent gets shown in the same way with a small "T/D" next to the green circle. The Top Of Descent is the point where you have to leave the cruise altitude and descent to your destination. Do note that upon reaching the Top Of Descent, the Altitude on the MCP needs to be reset.

Map Select Button Data

Additionally to the information shown in the figure on the previous page, it's possible to display so called Map Select Button Data. You have the choice to display Airports, Ground Reference Points and Navigation Aids by pressing the associated Buttons on the EFIS Control Panel.
The symbology is as follows:

○ EDNL   Airport

▵ ETOXU   Ground Reference Point

FHD   Navigation Aid

Plan Format

Compass Rose

North Reference

Centered Waypoint

Step through Waypoints (LSK6)

Range Selector

Format Selector
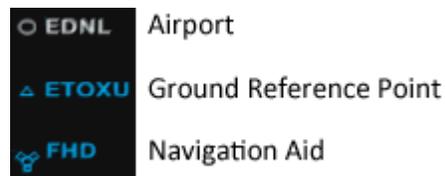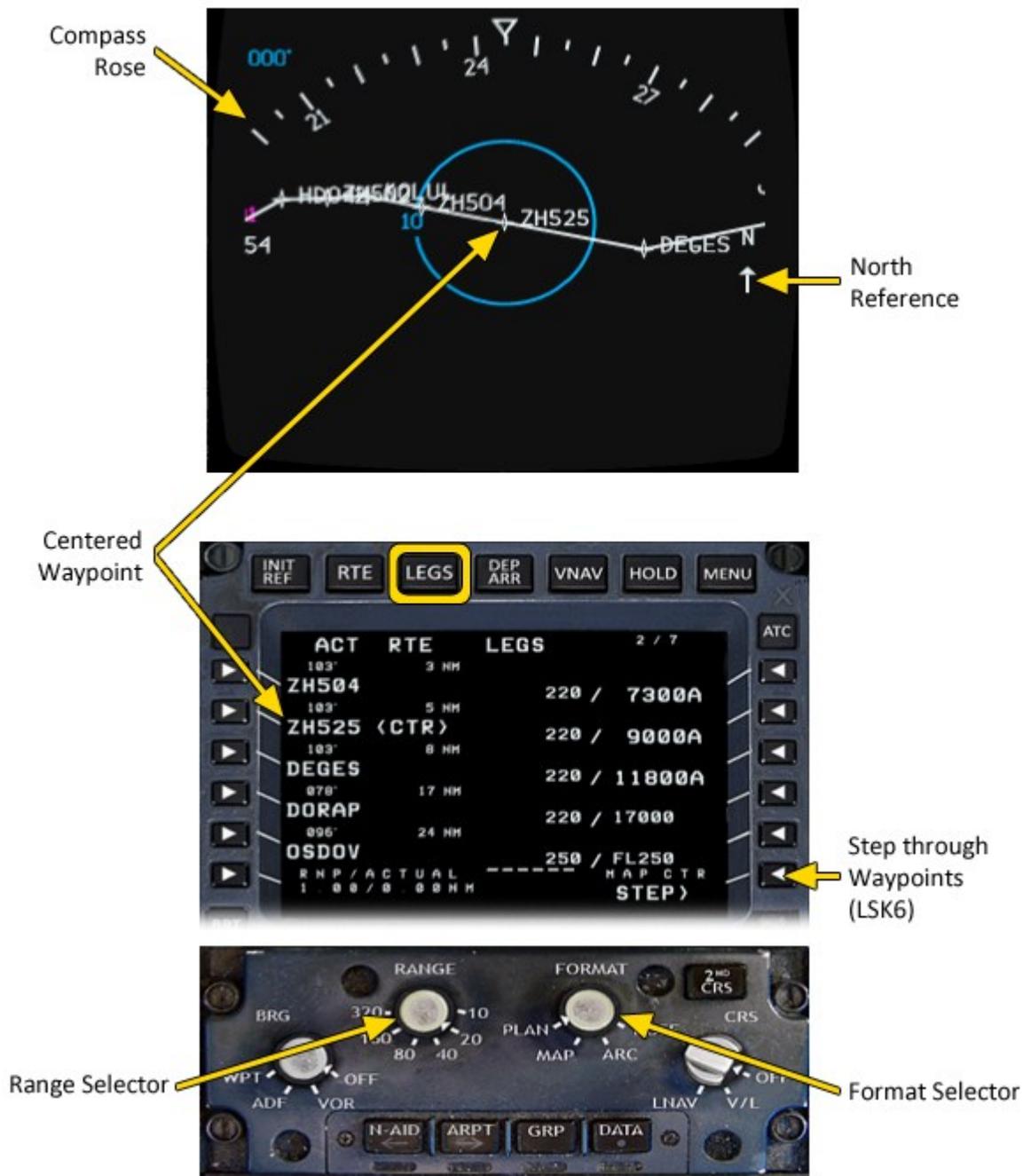
Unlike to all other formats, the Plan Format is **not** oriented to your aircraft's heading. Although it shows a compass rose at the top, it is **always** referenced to North.

Plan Format allows you to go through your programmed route without moving the aircraft. Go to the FMS "LEGS" page in order to see your waypoints. By pressing LSK6, you can step through each way-point.

The selected waypoint is indicated by a <CTR> label on the FMS and centered on the ND screen.

Horizontal Situation Indicator (BAe146)

The Horizontal Situation Indicator (HSI) provides the flightcrew with the magnetic heading, the selected heading, the course selection and lateral deviation, the glideslope diviation and the groundspeed, as well as distance to the next waypoint.
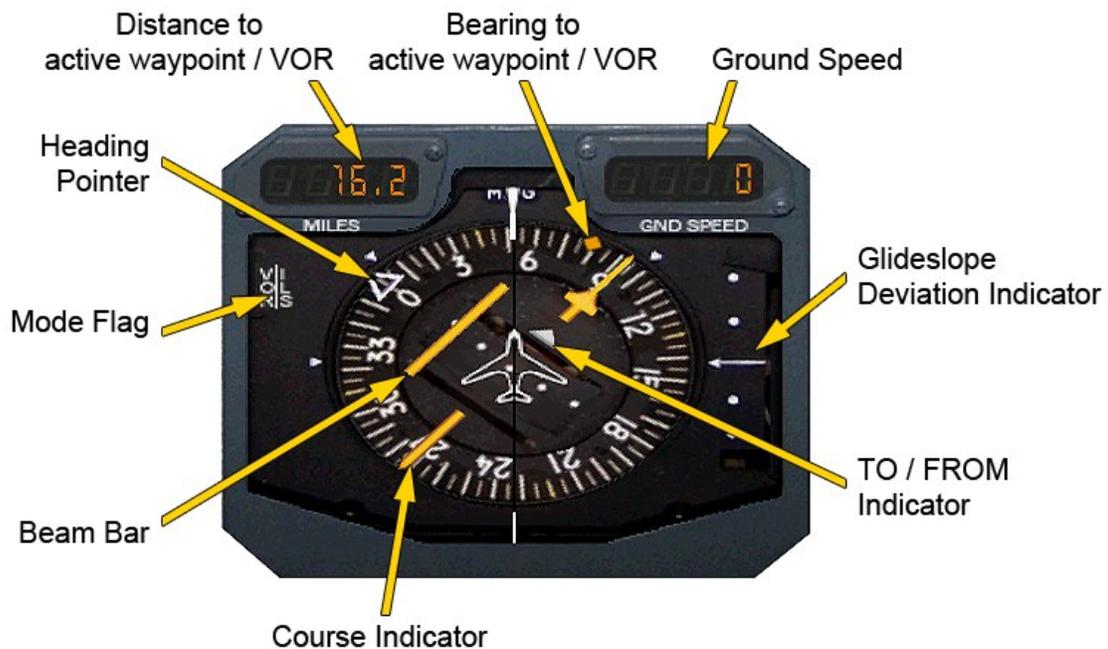
The HSI receives its signal depending on the NAV source selected on the MCP (NAV1, GPS or NAV2) and on the position of the HSI switch. The position of those two controls can be seen below:

By default, the HSI switch is set to the RNAV position, which means that it is coupled up with the GNS-XLS Flight Management System. In this case the course indicator resembles the programmed track and the beam bar the lateral deviation from such. In case no flight plan is loaded, this will be indicated by a red-white flag as can be seen below.

Move the HSI switch to the "NAV" position to display ILS or VOR information. In this case, either NAV1 or NAV2 will be used, depending on the setting of the NAV source selector on the MCP. The selected source will be indicated by the annunciators to the left of the HSI switch.

Airspeed Indicator (BAe146)
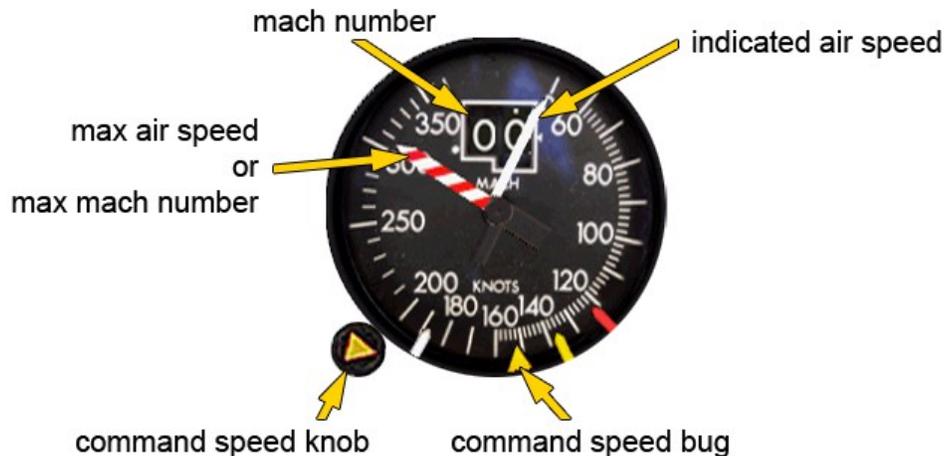
To the left of the EADI or ADI on the BAe146, the airspeed indicator can be found.
The command speed is used as reference for a climb/descent using the IAS autopilot mode and serves as the reference for the Slow/Fast indication on the EADI / ADI.

In addition there are three plastic reference bugs (red, yellow and white). They are mainly used for take-off, approach and landing.
The normal way of setting these reference bugs is as follows:

For Take Off:
Red Reference bug: V_1
Yellow Reference bug: V_R
Command Speed bug: V_2+10
White Reference bug: V_{FTO} (max flap retraction speed)

For Approach/Landing
Red Reference bug: V_{REF}
Yellow Reference bug: V_{REF} + 20 (Glideslope interception speed at Flaps 24)
Command Speed bug: as required
White Reference bug: V_{FTO} (max flap extension speed)

The above mentioned speed bug positions are automatically set when pressing the "TO" button on the TMS and when a descent is sensed or the "DESC" button on the TMS is pressed.

In case you want to manually adjust the position of the reference speed bugs, invisible clickspots can be found in each corner of the airspeed indicator. In particular this is:

Red Reference bug: left upper corner
Yellow Reference bug: right lower corner
White Reference bug: right upper corner

Altimeter
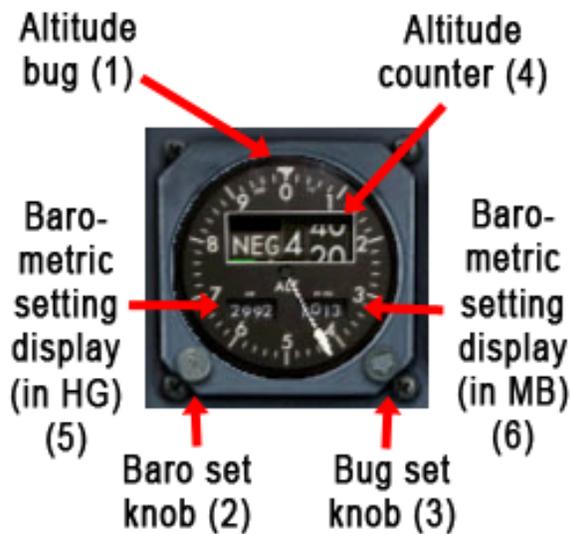
Immediately to the right of the PFD, a round altimeter gauge is fitted. The gauge has a dial, with the numbers 0 through 9 along the edges representing hundreds of feet (0 to 900 feet). A counter (Figure 86, 4) just above the dial's fasten point shows the current altitude above or below sea level. It has four rotating digits, of which the first two digits are combined to show altitudes of 00-20-40-60-80 feet. The other digits contain all number, being 0 – 9. As the dial turns, the counter's digits also turn. When under sea level, a NEG (NEGative) indication appears instead of the first two digits.

Two small counters can be seen just under the dial's fasten point. These are both barometric settings indicators. The left one (5) shows the barometric setting in HG, the right one (6) shows it in millibar. With the barometric setting knob (2) the barometric setting can be changed.

An altitude bug is also present (1). It is a small triangular, white object that can be found along the outer edge of the altimeter gauge. It can be set using the bug set knob (3).

Clock

The clock is placed all the way to the left on the main instrument panel. It has two LCD screens: the upper one shows the current time; the lower one may show elapsed time. This is a basic stopwatch that can be set to run, hold or be reset.

EFIS Decision Height and Dimming Controls

The EFIS dimming controls are only a small subpanel on the main instrument panel, and can be found to the left of the PFD. The only functional knob is the decision height knob (DH). Use it to set the decision height. Upon clicking the Decision Height will be shown in the lower right corner of the PFD.

Distance Bearing Indicator (DBI)

The Distance Bearing Indicator (DBI) is used for radio navigation. The instrument contains two LCD screens, which are distance indicators, and a compass with two dials, or bearing indicators. The two LCD screens display DME distance, while the bearing indicators display VOR or ADF bearings. The DME and VOR radios can be tuned via the VHF NAV controllers to the left and right of the MCP on the glare shield. The ADF radios can be tuned using the ADF box on the pedestal radio stack.

Standby attitude indicator

The standby attitude indicator can be found to the right of the main altimeter. It consists of a ball that is colored half blue and half brown, with a white strip between the two colors sections. The blue half signifies air and the brown half signifies earth. The white bar signifies the horizon. When the plane pitches up, the horizon will shift down, and when the aircraft pitches down, the horizon will shift up. There are also stripes and numerical indications on the brown and blue halves. These represent degrees pitch up (in the blue half) and pitch down (in the brown half). The exact amount of pitch-up and pitch-down attitude can be read by looking at the W-shaped symbol on the attitude indicator. This W represents the plane.

When a ILS frequency is tuned in the VHF NAV 1 radio, two deviation bars will appear. Both of them are metal rods with five yellow strips fastened to them, all of varying lengths. These strips represent dots, which in turn signify deviation from the localizer course and glideslope. If any of the bars should fail, red flags saying G/S, for a glideslope fail, or LOC, for a localizer fail, will appear. If a VOR frequency is tuned, all flags will be hidden from view.

Along the top an arc of stripes can be seen, with a rectangular, white indicator at the very center. The white stripes along the attitude indicator's edge represent increasing bank angles to either side. The bank angle is read using the central white triangle: this points to the current bank angle.

The knob in the lower right corner is the fast erection knob. When the gyro that powers the attitude indicator's readings aligns and comes up to speed, it will display a random attitude. By pulling the fast erection knob, the attitude indicator is caged and reverts to 0 pitch. Always make sure to do this before takeoff! Should the gyro fail, a red/black striped gyro fail flag will appear at the top of the attitude indicator.

TCAS traffic display

TCAS introduction

TCAS is a system that warns you for proximate traffic and can give advice on how to avoid said traffic if it comes to close. Traffic is considered proximate when it is at a range closer than 6NM to the plane, and within 1200 feet above or below the plane. The system is controlled using the TCAS and Transponder panel on the radio stack. The display on the main instrument panel shows the traffic that TCAS detects. Note that everything that is displayed on the TCAS display is relative to your aircraft.

The display has several standard indications, even when no traffic is detected and displayed on the TCAS display:

−   A white aircraft symbol representing your aircraft

−   A dotted circle around the aircraft symbol. This represents the "warning zone": A fictive zone that TCAS creates around the plane in which the pilot has to perform an action in order to avoid collision with the traffic

−   A white, solid arc. This arc symbolizes the boundary of TCAS's reach

−   A small numerical indication in the upper right corner. This shows the current range that TCAS detects traffic in. The TCAS display in the figure above shows a range of 10 NM. This range cannot be changed.

TCAS aircraft symbology

Aircraft are shown using a variety of icons depending on their distance to you, in a variety of colors. The symbology is as follows:

−   Above the icon is an altitude indication. This altitude indication gives the difference in altitude between you and the traffic in hundreds of feet. If a plane is at your height, it will show 00. If it is higher than you by 500 feet, it will show +05. If it is lower than you by 500 feet, it will show -05.

−   There may or not be an arrow drawn to the right of the figure. An arrow pointing up means that the aircraft is climbing by more than 500 feet per minute. An arrow pointing down means that the traffic is descending by more than 500 feet per minute

– The traffic may be symbolized by an empty cyan caret if it is not proximate.

– The traffic will be displayed using a filled cyan caret if it is considered proximate (within 6 NM and a vertical distance of 1200 feet to you).

– A yellow circle symbolizes an aircraft in the caution zone. Traffic is now considered an intruder and could potentially lead to a collision. At this point the traffic has entered a fictional "Caution zone". Here danger is low, but the traffic is close enough to be potential threat. An aural warning TRAFFIC will be heard.

– A red block symbolizes traffic that is close enough to cause a collision if the pilot does not do something. The traffic is now in the Warning zone, which was introduced earlier. A resolution advisory will be given which the pilot must follow up on to avoid a collision.

TCAS advisories

TCAS gives two types of advisories when traffic is proximate enough to warrant an alert: traffic and resolution advisories. Traffic advisories are merely alternative, for they only alert the pilot to the traffic. Resolution advisories tell the pilot what to do on the other hand. They come in two types: preventative and corrective.

– Preventative resolution advisories ask the pilot to keep the plane somewhat level. An aural annunciation MONITOR VERTICAL SPEED will alert the pilot to keep the plane within a on the PFD given range of vertical speeds.

– Corrective resolution advisories ask the pilot to perform a vertical evasive maneuver to increase separation between you and the traffic. Either you'll have climb (aural annunciation CLIMB) or descend (aural annunciation DESCEND). If this does not happen fast enough, an aural annunciation INCREASE DESCEND or INCREASE CLIMB may be heard.

Standby altimeter and Airspeed Indicator (ASI)
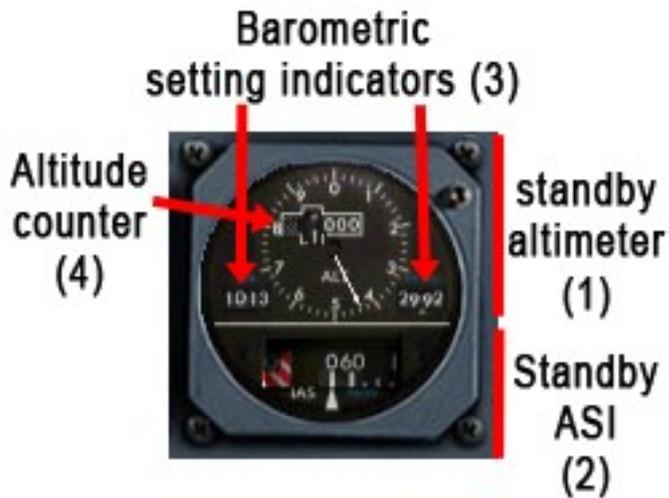
A combined standby altimeter and speed indicator (ASI) can be found next to the TCAS display. The upper two-thirds of the gauge contains a standby altimeter (1). It is similar to the main altimeter in both form and function. Its main component is a round clock-like display, where the numbers along the edges correspond with hundreds of feet (0 – 900 feet). An altitude counter (4) displays the current altitude. Two barometric setting indicators (3) can be found to the left and right of the altitude dial. The left one displays the altitude in millibar, while the right one displays it in HG.

The lower third of the gauge contains a standby speed indicator (2). It contains a disc-like gauge with speeds written on its side. The disc turns to the left as the airplane accelerates and turns to the right as the airplane decelerates. A white triangle under the disc points to the current speed. The speed is displayed in knots.

Flight Annunciators

These annunciators illuminate when general events have taken place on the plane, pertaining to the FGS or control surfaces.

1. **CMPRTR MSTR**: The EFIS Symbol Generators (SGs) have a comparator system that compares SG 1's output against SG'2 output and vice versa. If a discrepancy has been detected, the CMPRTR MSTR (Comparator master) annunciator will illuminate. On the PFD it will be written what exactly mis-computes.

2. **AP**: This red warning light announces autopilot disengagement

3. **AT**: This amber caution light announces autothrottle disengagement

4. **FTC**: This annunciator is inoperative

5. **EL TRIM**: annunciator indicating that either the manual or automatic elevator trim has failed

6. AIRBRK: Illuminates when the air brake is not fully in

7. **YD**: Annunciator indicating that there is a complete loss of yaw damping (Y/D) power

8. **AUTO LAND**: Annunciator that illuminates when the aircraft is correctly configured for a category 3 autoland

9. **CAT 3**: Annunciator that illuminates when the aircraft is correctly configured for a category 3 auto-land. It always illuminates simultaneously with the AUTOLAND annunciator

10. **CAT 2**: Annunciator illuminating to indicate that a CAT 2 status landing has been achieved, when a CAT 3 status landing couldn't be achieved. It does not illuminate if the CAT 3 annunciator illumi-nates

11. **SPLR Y**: Annunciator indicating that the yellow (Y) spoilers (SPLR) are deployed

12. **SPLR G**: Annunciator indicating that the green (G) spoilers (SPLR) are deployed

Flight Guidance System status annunciators
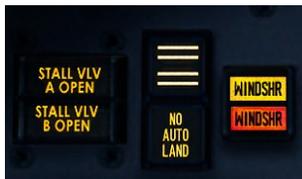
This small group of annunciators gives status warnings on the Flight Guidance System.

- **NO AUTO LAND**: This annunciator will illuminate when no autoland status has been achieved and the plane descends below 900 feet radio altitude (RA)
- **WINDSHR** : Annunciator indicating that an increasing performance windshear has been detected
- **WINDSHR** : Annunciator indicating that a decreasing performance windshear has been detected

Brake pressure gauges
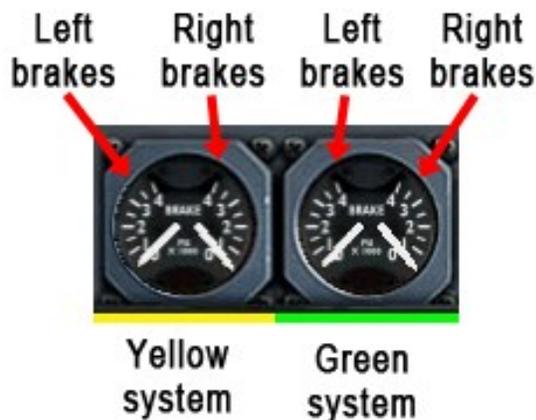
The brake pressure gauges are two round gauges found at the bottom of the instrument panel. Each one has two dials that are fastened in the middle of the gauge and each points and moves in a different half of the gauge than the other does. The left brake pressure gauge indicates brake pressure when provided by the yellow hydraulic system, and the right one indicates brake pressure when provided by the green hydraulic system. On the gauges, the left dial always corresponds to the left-side brakes, and the right dial to the right-side brakes. Note that the gauges do not necessarily provide an indication of brake pressure at the wheel brakes. Exact brake pressure at the wheel brakes may be different due to the antiskid system modifying brake pressure to stop the wheel from skidding.

2. FLIGHT GUIDANCE CONTROLS AND WARNING LIGHTS

The flight guidance controls and warning lights can all be found on the glare shield, The glare shield itself is spilt into five sections: the center contains the actual MCP, which features almost all controls necessary to interact with the *Flight Guidance System*, or FGS. To the left and right of the MCP, we find several warning lights, which alert the pilot to small or big problems on the aircraft. These are called "attention getters" for they get the pilot's attention, who then looks at the master warning panel to find what has gone wrong. In between the attention getters and the MCP, we find NAV panels, which would be the last two sections on the glare shield.

Attention getters

To the left of the NAV 1 panel, we find six annunciation lights, or "attention getters" as they are commonly called. Four of these annunciators alert the pilot of specific events that happen or conditions that arise. The final two annunciators give a more general idea of things that are happening:

1. **LIFT SPLR**: This annunciator turns on when the lift spoilers were not deployed, even though they should have. You can press the annunciator to reset the warning

2. **FLARE**: This green annunciation indicates that the Flight Guidance System has started its flare maneuver

3. **GROUND PROX**: An EGPWS annunciator, it gives protection against flight into rapidly rising terrain by alerting the pilot to ground proximity. It will light up if the descent rate is excessive for the current altitude. The descent rate is measured by means of the current radio altitude against the rate of change of the radio altitude. An aural warning TERRAIN, TERRAIN is played when the GROUND PROX annunciator lights up

4. **PULL UP**: A second EGPWS annunciator, this annunciator is a second stage of the GROUND PROX annunciator. If the plane continues to descend, the PULL UP annunciator will illuminate, and an aural PULL UP annunciation will be played. The annunciator is inhibited if the plane is in landing configuration.

5. **Master warning annunciator**: This annunciator indicates that something on the aircraft requires immediate attention. Press the annunciator to cancel the warning.

6. **Master caution annunciator**: This annunciator cautions the pilot for something that as yet might not be of great concern, but good be detrimental for flight performance and safety if ignored. Press the annunciator to cancel the warning

NAV1/NAV2 panels

There are two VHF NAV panels on the Avro RJ / BAe146 series. One can be found to the left of the MCP, the other one to the right of the MCP panel. The left one controls the NAV 1 radio, the right one the NAV 2 radio. The Figure above shows the left NAV panel, which controls the NAV 1 radio.

The NAV panels have four components. First of all, the prominently visible LCD screen displays two frequencies. The upper line shows the active VOR or ILS frequency. The bottom line shows a preselected frequency. Use the interchange switch to swap the two frequencies, and get the preselected frequency to be to the active frequency and vice versa.

Two concentric frequency selector knobs are placed under the LCD screen: the outer one controls the digits to the left of the decimal point, and the inner knob controls the digits to the right of the decimal point.

A DME rotary switch with three positions. The three positions are STBY, ON and HOLD. This is not simulated and is always in the ON position.

Use the NAV panels in conjunction with the course knobs on the MCP. For the NAV 1 panel, use the course knob directly to the right of the NAV 1 panel. For the NAV 2 panel, use the course knob directly to the left of the NAV 2 panel. The course knobs are used to set the course in which direction the VOR or ILS station is placed.

MODE CONTROL PANEL (MCP)

The Mode Control Panel, abbreviated to MCP, is the central location for controlling the Flight Guidance System (FGS). Here you can turn the flight directors on and off, you can select modes according to which the flight director will issue commands and you can turn the autopilot on and off.

About the MCP

The MCP's layout probably seems cluttered and hard to understand, but within the mess there is a clear functional philosophy: all the switches that control an aspect of the FGS have been grouped together. The various button groups control the following FGS aspects (numbers in the list correspond to the numbers in the Figure above):

1. The two flight director (F/D) switches (1)

2. F/D and A/P modes (2), distinguishable in two separate categories
   a. Vertical navigation modes
   b. Lateral navigation modes

3. Autopilot disengage/engage controls (3)

This grouping doesn't hold up in *every* respect, but you'll find that for the most part it's true. All the button groups will be explained in due course. First, however, it may prove beneficial if you have a better understanding of how the FGS operates before delving into its multitude of functions.

HOW TO USE

With its multitude of modes, it might be confusing what modes should be used when. In this subchapter, an overview is given of when to use what modes. Note that explanation of the actual modes is given in later chapters.

Before takeoff

First thing to switch on is the F/D. Common procedure has the F/D switched on as you taxi out into the active, but make sure they are activated before takeoff. Upon doing so, they will automatically engage in TO/GA (Take-Off/Go-Around mode). Secondly, before taxiing onto the runway, set the A/T master switch to ARM. It will help setting thrust to the correct N1 for takeoff. N1 can be selected on the TRP. Before takeoff, with the A/T armed, you should see on your PFD a white A/T legend, a green TO legend and a green TRK legend. After pressing the TO/GA button, the white A/T legend should become green, and next to it TO MAX should appear for a maximum thrust takeoff, or TO REDU for a derated (reduced thrust) takeoff.

Crossing 350 feet

Crossing 350 feet you have a choice on what to do. At this point, all the Take-Off related modes are still activated. Depending on how you prepared you flight, you can do one of several things:

−   If you entered a flightplan into the FMS besides entering one into the default Flight Simulator flight planner, you can now press LNAV and VNAV. This will see the aircraft climbing and navigating according to do data entered into the FMS.

−   It's not uncommon for pilots *not* to use VNAV. So, what you may do also, provided that a flightplan was entered into the FMS, is engage LNAV, but not use VNAV for vertical navigation. You Instead, select the altitude you want to climb to, select the speed you want the A/T to hold, and then press LVL CHG.

−   Alternatively, if you did not enter a flightplan into the FMS, but did enter one using the Flight Simulator flight planner, you can press the GPS button. This will make the aircraft follow the default flight planner entered flightplan. For vertical navigation, use LVL CHG. To do this, set the altitude you want to climb to and set the speed you want A/T to hold. Then press LVL CHG.

Cruise

During cruise you won't have much to do. If you do not use VNAV, you might have to check the speed that A/T is holding, and whether you don't want to set it higher or lower. Otherwise, you have nothing to meddle with until descent.

Descent

During descent it really depends, again, on the modes you are using during cruise. Overall, if you use LNAV or GPS, that doesn't make a difference, so leave whatever lateral mode that's engaged on for now. It's the vertical mode that you'll be busy with.

At some point, ATC will instruct you to descend. At this point, you have three options:

– Use VNAV descent. To engage it, simply set a lower altitude than your current altitude (preferably the one ATC clears you to), and wait for the plane to cross the top of descent point. VNAV will then automatically start the descent

– Use LVL CHG descent. To engage it, set a lower altitude than your current altitude (preferably the one ATC clears you to), see if the speed you are flying at is the speed that you want to descend with (note that below 10000 feet you should fly 250 kts or less!), and press LVL CHG. This will trigger the LVL CHG mode and start the descent

– Finally, you can use V/S. Vertical Speed mode is however not recommended. To engage it, set a lower altitude than your current altitude (preferably the one ATC clears you to), and choose a negative descent rate. Make sure it's not too shallow or to steep

Of all modes, LVL CHG will probably be the easiest to use. VNAV might give problems when used in conjunction with default ATC, and V/S requires lots of attention where LVL CHG makes for a fully automated descent that can fully comply with ATC's instructions.

Regarding lateral navigation, it depends on what you wish to do. If you use default ATC, then at some point ATC will direct you to fly a certain heading. If you want to comply, then select the requested heading, and press HDG SEL. This will get the plane to turn to the ATC requested heading.

If you use default (or any other) ATC, and wish to fly a STAR, that's also not a problem of course. In that case you should simply ignore ATC's calls (but do acknowledge them, or default ATC might cancel your flight!) and keep GPS or LNAV mode ON. This will make sure the plane follows the flightplan and the STAR, if selected.

Approach

The approach procedure depends on what kind of approach you are flying.

– If you fly an ILS approach, you can set the FGS up for a full autoland
    ◊   Tune the ILS frequencies into both NAV radios
    ◊   Set the ILS course using both course knobs on the MCP
    ◊   Press the VOR/LOC button. This will not disengage any lateral mode you already have engaged, but will ARM LOC mode for ILS localizer capture
    While the autopilot aligns with the runway, align mode (ALN) will engage. Now you wait until the autopilot capture the localizer

– If you fly a non-ILS approach (because there is no ILS, or because the approach doesn't warrant a possibility, much like the KJFK Canarsie VOR 13L approach), then there's not really anything to set up. In these cases, though, you'll probably have to fly the plane yourself. So get ready to disengage the A/P.

Regarding vertical mode, you'll probably want to use LVL CHG at this point. It is the easiest way to get your plane to climb or descent quickly if need be, and you have direct control over the speed at which the plane flies, which, on approach, may be a very important asset.

If you fly a STAR however, VNAV might also suit you very well. You may choose yourself, just be sure to get low enough to capture any localizer. ATC will instruct you, or otherwise you can check the approach charts of the airport.

Final approach

When on final, it depends, again, on the approach you are flying what you are going to do.

> If you fly a straightforward ILS, then by this time the autopilot should have captured the localizer, and LOC mode should be armed. When this happens, arm APP mode. This is a vertical mode, which will allow capture of the glide slope. You will see GS 1 or GS 2 armed on the PFD. Once the glide slope is captured, GS 1 and GS 2 will become the active vertical modes. If everything is correctly configured, the autoland function will engage. For a full autoland, the following conditions have to be met:
> - Both ILSs should be tuned and correct.
> - The A/P is engaged and the active modes are LOC 1 and 2 and GS 1 and 2. (1 for captain's side, 2 for F/O's side).
> - The RA is between 1500ft en 600ft.
> - Flaps at 24 degrees or greater.

> One autoland is engaged, a new vertical mode will be armed: flare (FLR). This will automatically flare the aircraft before touchdown. IF a white NO AUTOLAND annunciator illuminates (Figure 109), it means that one of the above conditions wasn't met.

> If you do not use an ILS, you should probably be hand flying your plane to the runway now. Use the PAPI lights as a reference of how to fly. If you are not hand flying right now, you can disengage the autopilot either by pulling down the autopilot emergence disengage bar, or use the AP DISC button on the control yoke. The latter is the normal way of disengaging the A/P. Do *not* disengage the A/T or F/D, however! These will still help to guide you down the runway. When at 50 feet RA, disengage A/T and set throttle levers to idle. You can disengage the A/T by setting the A/T switch on the MCP to OFF, but a preferred method is to the A/T disengage switch on the outboard throttle levers.

Touchdown

If you were using an autoland, the airplane will do everything automatically. The new lateral mod will be ROLL, which will simply roll the aircraft down the runway until disengages. The active vertical mode will be GRND, which will lower the nose and keep it on the ground until disengaged.

If you were flying manually, then there's nothing left to do. When you exit the runway, you can turn off the F/D. You won't need them anymore during this flight.

Introduction to the Flight Guidance System

Usually, the autopilot is seen as not only the heart, but also as the brain of the aircraft. This idea of the autopilot is wrong however. It is not the all-governing flying system that people think it is. The contrary is true: it is a slave of other systems.

The actual brain on the aircraft is the Flight Management System (FMS). This system, accessed via the FMS CDU located on the forward section of the pedestal, is what plans everything that the FGS does. It issues commands to climb to an altitude, to descend to an altitude, to increase speed or decrease speed. However, the FMS is only programmed to plan, not to execute! This is what the FGS does: when the FMS is correctly configured and the FGS is correctly set up, the FMS will issue commands to the FGS, which will in turn execute these commands.

FGS components

The FGS itself is broken up into three parts: the flight director (F/D), autopilot (A/P) and autothrottle (A/T). Each of these components has a specific task and is controlled using the Mode Control Panel (MCP) on the glare shield. However, make no mistake: as interwoven as these three subsystems seem, so big is also their separation. Figure 98's main point that it tries to convey, is the separation between the flight director, autothrottle and the autopilot. Not only is there a functional difference, there's also a very important operational distinction.
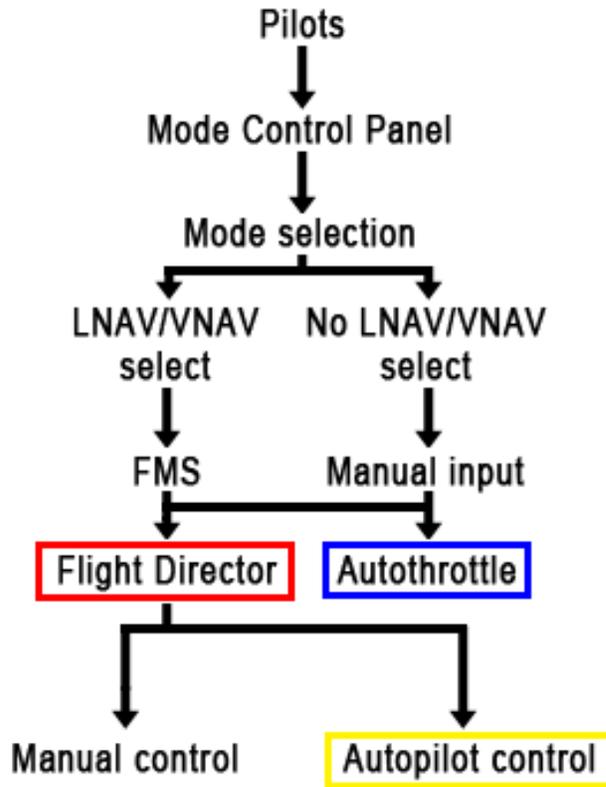
Figure 39: Operational schematic of the flight guidance system

Figure 39 may surprise you. Besides it giving an operational schematic, it also hints at the hierarchy that is present within the FGS's operation. The pilot is always at the top, for he controls which FGS modes are active and inactive; indeed, he can choose to leave everything off too. Selecting the modes is done via the Mode Control Panel, which is why the MCP is below the pilots. On this panel there is a multitude of buttons through which each and every of the FGS modes may be activated. This is called mode selection, and this is also the next step in the schematic.

FMS and manual modes

To understand the next step in the schematic, it is important to understand the difference between the various modes available to us on the MCP. There are what you may call "FMS" modes and "manual" modes, with which we hint at who is in control when that mode is active. The FMS modes are VNAV and LNAV, which in fact are simply acronyms of Vertical NAVigation and Lateral NAVigation. When these two modes are active, the FMS talks directly to the FGS and tells it what to do and when to do it. Do note that you do not have to activate these modes at the same time. VNAV can be on without LNAV being on and vice versa.

Besides FMS modes, there are also many manual modes. The manual modes are modes in which the pilots talk to the FGS directly, not the FMS. In these modes, the pilots set the desired parameters themselves, using the various knobs on the MCP. The manual modes are, for example, the heading (HDG) and vertical speed (V/S) modes. In the former, the pilot sets the heading in which to fly, and in the latter he sets a climb or descent rate.

Note that each of the modes on the MCP will be discussed in detail later, FMS modes as well as manual modes.

The next step in the schematic

Now that FMS and manual modes have been cleared up, this next step will be a piece of cake. The next step is, as can be seen in Figure 98, a split in the flow caused by the activation of VNAV, LNAV, or both. Since VNAV and LNAV are "FMS modes", the FMS will handle either one or both lateral and vertical navigation if either one or both of the LNAV and VNAV modes have been activated. If these are not activated however, then manual input will be necessary using the associated knob. As such, depending on the pilot's selection via the MCP, the FMS or the pilot will set the parameters for lateral and vertical navigation.

In the end it doesn't make a difference who gives the command, whether it is the FMS or the pilot himself, for the next link in the chain will always interpret them, calculate what needs to happen, and act on these calculations. This next link in the chain is represented by the F/D (Figure 39, red box) and the A/T (Figure 39, blue box). The interesting questions now are: what is the difference between the F/D, A/T and A/P?

The distinction between flight director, autothrottle and autopilot

You will have noticed that in Figure 39, the F/D, A/T and A/P are placed at different positions within the schematic, and are not grouped together into one big FGS. This is because these three FGS subsystems have different functionality. As was said, FMS or manual input in the MCP sends commands to the F/D and A/T to change things. As such, the best way to summarize the functionality is that they operate as a "calculator". They calculate what needs to be done, how it needs to be done, and when it needs to be done, in order to obey the commands that were input on the MCP, or that were sent by the FMS.

If both of these are calculators, why are they not grouped into a single functional entity? Why is their operation separated into two systems that seem to be functionally the same? Here is where the difference between the F/D and A/T becomes apparent. While the F/D strictly calculates the correct flightpath, the A/T is more than that. It is also an executor. As a result, A/T and F/D can be separately operational. One can be activated without the other being activated.

If the F/D and A/T do all the calculating stuff, then how does the A/P come into all of this? The A/P is only an executor. It receives calculations from the F/D, and acts on them. Because of this, it is at the very bottom of the schematic. The A/P is merely a slave of the F/D. As such, the A/P can't function without the F/D, so the A/P will not take command of the plane if the F/D is not active.

In summary, the FGS's subsystems each have their own operation and functionality:
– The F/D is the main calculator to calculate the flightpath
– The A/P executes the calculations done by the F/D
– The A/T calculates and executes throttle input to help reach a certain speed

The integrated nature of FGS subsystems

Despite the fact that the three FGS subsystems are separated from each other, each assigned to calculating and/or executing a certain aspect of flight, they are also integrated and inexplicably linked to each other. See Figure 40.
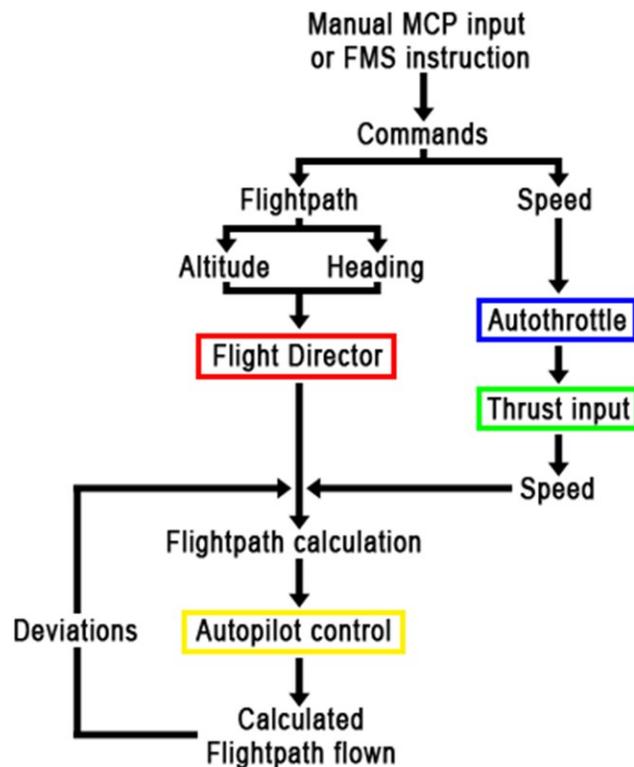
Figure 40: Integration of the GFS subsystems

Figure 40 shows a flowchart of how the various FGS subsystems are integrated; how they operate using each other's information to determine the aircraft's flightpath and speed.

1. As always, it starts with manual input via the MCP, or an automatic instruction via the FMS. Via either way, a command is sent to the FGS. These commands will be in the form of "fly to heading x, fly at altitude y and fly at speed z".

2. The F/D will process the heading and altitude commands, and the autothrottle will process the speed command.

3. The result is that the autothrottle will increase or decrease thrust depending on the difference between the current speed and the target speed. This is termed as "thrust input", but literally it means that the throttle levers will be moved to the calculated position in order to reach the target speed.

4. The different thrust input will result in a different speed, and now comes the crucial bit…

5. The F/D will now calculate the flightpath based on three things:
    a. The difference between current heading and target heading
    b. The difference between current altitude and target altitude
    c. The difference between current speed and target speed

6. With the flightpath calculations done, the calculations are forwarded to the PFD, where they appear graphically in the form of the horizontal and vertical deviation bars. If the autopilot is activated, which is assumed in this explanation, then the flightpath calculations are also forwarded to the A/P.

7. The A/P will take the F/D's calculations, and execute them by moving the aircraft's control surfaces.

8. Due to weather conditions, maybe even failures on board the aircraft, the A/P may not be able to comply to the F/D's calculations, however. In this case, deviations from the flightpath may occur. The F/D will take the deviations into account, together with the current speed, and will output new calculations, which again will be forwarded to the A/P.

9. This will result in a circular on-going process, until either one of the following events occur:
    a. New commands have been given for the FGS to execute
    b. The F/D has been turned off, at which point the A/P will not be able to fly the plane anymore. A/T may still be activated however.

The crucial point is in step **5c**. What it means is that while the F/D does *not* have the ability to command or execute changes in thrust input, it *does* take into account the current speed and the target speed to calculate a flightpath.

A/T does *not* do this. A/T only looks at the current speed, whether a change is necessary, and if so changes thrust input. If not, it will trim the thrust input in order to stay at the target speed, or as close as possible anyway.

This shows that the A/T truly is rather separated from the rest of the FGS, but only up to a point. A/T itself does not listen to any of the other systems, but other systems listen to it. The F/D treads on the territory of the A/T and uses speed to calculate the flightpath. The A/P being linked to the F/D in the slave-like manner in which it is, is thus also linked to the A/T.

About the A/T

Autothrottle or A/T controls engine thrust to do one of the following things:

– Reach and hold a target speed (also called "controlling to speed")
– Reach and hold a target thrust rating (also called "controlling to thrust rating")
– Retard the thrust levers

When the A/T tries to reach and hold a target speed, it will use the speed set on the MCP as a reference. In other words, the speed set on the MCP IAS/MACH window (Figure 43, 2) will be the speed it tries to reach and hold. However, this doesn't mean it can use any thrust rating that is available. The A/T is bound to certain limits. The maximum limit is displayed on the Thrust Rating Panel (TRP). The A/T controls to speed when the vertical mode is set to vertical speed (V/S), altitude acquire, altitude hold (ALT HOLD) or glideslope (G/S).

When a thrust rating is reached and held, it references to the thrust rating selected on the TRP. It does this in the vertical modes takeoff and go-around (TO/GA), and in a level change climb (LVL CHG), where it will use the maximum allowed thrust depending on the thrust rating selected.

Retarding the thrust levers is done during an autoland flare and during a level change descend (LVL CHG), where it will simply retard the throttle levers to reach the minimum thrust allowed at that time.

When the A/T is not active, the A/T throttle status legend's position of the PFD will be blank. When armed, there is a white "A/T" on the PFD. When engaged, it will be green, and when disengaged it will flash in yellow.

What will follow now is a description of all the MCP controls with which the FGS can be controlled, except for the FMS. This will be explained in a later chapter.

Course selectors

Figure 41: MCP VHF NAV 1 and 2 course selectors

The course selectors on the MCP can be found on the outer edges of the MCP (Figure 41). The left one controls the VHF NAV 1 course, the right one the VHF NAV 2 course. Both course selectors are identical in function and operation. They have a display that shows the currently set course. A knob under the display, featuring a yellow cross that is reminiscent of an airplane seen from above, is used to set the desired course.

Flight Director switches

Figure 42: Flight Director (F/D) switches

The flight director (F/D) switches allow you to turn on the flight directors. There are two flight directors, called "1" and "2". The left F/D switch controls F/D 1, the right one F/D 2. A MA annunciation above the switch will illuminate if that F/D has been turned ON and is used to guide an A/P.
The F/D is an essential part of the autoflight system, and is always turned ON even before takeoff. It has to be ON in order for the autopilot to be able to take control of the aircraft. It gives commands that the pilot may follow on how to fly the plane. What commands these are depends on the autopilot modes that are selected. These will be dealt with in the coming chapters.

When the F/D is active, a vertical and horizontal bar will appear on the PFD. The horizontal bar moves vertically over the PFD's attitude indicator, and it is a measure for vertical deviation from the F/D commanded flight path. The vertical bar moves horizontally over the PFD's attitude indicator and is a measure of the horizontal deviation of the F/D's flight path. The goal is to get these in the middle, so that they form a perfect, symmetrical cross with each other. In that configuration, it means the plane is flying exactly according to the F/D calculated flight path.

F/D and A/P modes

Figure 43: F/D and A/P modes on the MCP

The MCP is not called Mode Control Panel for nothing. It offers a portal to activating and deactivating all the various F/D and A/P modes. These will be discussed here. The numbering in Figure 43 may seem chaotic, but it has a system:

− Numbers 1 – 11 are merely controls to set the parameters for the various modes, but you can't activate any modes using these buttons

− Numbers 12 – 17 are vertical navigation modes

− Numbers 18 – 21 are lateral navigation modes

The various buttons, switches and knobs will be discussed in the above order. Note that at all times, only one vertical and only one lateral navigation mode may be selected. When one vertical mode is engaged and a different one is selected, the previous one will disengage.

Mode parameter controls

1. A/T OFF/ARM switch: Turns the autothrottle OFF or, when on the ground ARMs it or when in the air engages it. When the autothrottle switch is in the ARM position, a green lamp illuminates to acknowledge that.

2. IAS/MACH display window: Displays the speed set with the speed selection knob. When blank, the FMS has taken over the autothrottle and when automatically set the required speeds. The FMS set speeds can be seen on the PFD.

3. C/O button: This button changes the unit in the IAS/MACH display window. Press it to change between knots and Mach.

4. Speed selection knob: Allows the crew to select a speed using the IAS/MACH display window.

5. HEADING display window: Displays the heading set using the heading selection knob.

6. Heading selection knob: Allows the crew to set a heading, visible in the heading display window. Note that this is the *inner* knob of two concentric knobs.

7. ALTITUDE display window: Displays the currently selected altitude.

8. Altitude selection knob: Allows the crew to set a new altitude with the altitude selection knob.

9. VERT SPEED display window: Displays the current vertical speed if in vertical speed mode.

10. Vertical speed selection knob: Allows the crew to manually set a vertical speed, which will be visible in the vertical speed display window.

Vertical navigation modes

11. **THRUST** button: This button engages THUST mode. When ON, *there is no annunciation that says so!* The mode is a bit different than any of the other modes. It doesn't have one discrete mode, like most of the others. When pushing the THRUST button, you activate the FGS's speed mode, which is similar to all other plane's speed mode: it will hold the currently selected speed. However, depending on the flight phase, it might operate differently. For example, in a climb, it will set thrust to what is selected on the TRP. Usually this is CLIMB NORM. When the airplane is flying level, it will go into IAS or MACH, the normal speed mode. Use the IAS/MACH display window and speed selection knob to set the required speed.

    Depending on the flight phase, one of the following legends may be displayed on the PFD:

    ◊ If climbing and using a normal rating on the TRP, CLB NRM will be displayed.

    ◊ If climbing and using max thrust, CLB MAX will be displayed.

    ◊ If flying level and using the maximum continuous thrust TRP setting, MCT will be displayed.

    ◊ If flying level and the normal speed mode, units in knots, is selected, IAS will be displayed.

    ◊ If flying level and the normal speed mode, units in mach, is selected, MACH will be displayed.

12. **LVL CHG** button: This button engages level change mode. When ON, an ON annunciator illuminates on the button. In level change mode, the plane descends or climbs to an altitude set in the altitude display window, according to a speed set in the speed IAS/MACH display window. For this mode to engage, a different altitude than the one set has to be selected.

    The speed will be held not by changing thrust as needed; it will be held by changing the vertical speed. In level change climb, autothrottle will set thrust to the selected thrust rating on the TRP. In level change descent, it will fully retard the throttles. If the speed cannot be held between a maximum and minimum speed and the vertical speed has also reached its limit, the A/P and F/D will automatically disengage.

    In LVL CHG mode, the vertical navigation indication will be either IAS or MACH, referencing the speed unit that is used at the present flight phase.

13. **VNAV** button: This button engages VNAV mode, which stands for Vertical NAVigation. When ON, an ON annunciator illuminates on the button and the FMS will take over vertical navigation.

14. **APP** button: This button engages approach mode. When ON, an annunciator illuminates on the button. This mode is engaged to capture the glideslope (G/S) during landing. It allows the autopilot to perform an autoland. Speed is controlled by selecting a speed in the IAS/MACH display window, which the autothrottle will attempt to hold.

    When the glideslope is captured, a variety of legends may appear on the PFD:

    ◊   If the ILS frequency was tuned into the NAV 1 radio, a green GS1 legend will appear on the PFD upon glideslope capture. When it is white, it is armed, not active as yet.

    ◊   If the ILS frequency was tuned into the NAV 2 radio, a green GS2 legend will appear the PFD upon glideslope capture. When it is white, it is armed, not active as yet.

    ◊   If the same ILS frequency was tuned into both NAV radios, a green GS* legend will appear on the PFD upon glideslope capture. Note that there is no white (armed) version of GS*.

15. **ALT HLD** button: This button engages altitude hold mode. When ON, an annunciator illuminates on the button. In this mode, an altitude, set in the altitude display window, will be held and will not be deviated from unless otherwise instructed by engages one of the other vertical modes.

    Altitude hold may also get engaged through the altitude acquire mode. Altitude acquire mode is engaged automatically when, during an automated descent or climb via other vertical modes, the altitude set in the altitude display window is nearly reached. It will then engage altitude acquire mode to acquire the selected altitude, after which it will engage altitude hold mode.

    When in altitude hold mode, ALT will be displayed on the PFD. When in altitude acquire mode, ALT ACQ will be displayed on the PDF.

16. **V/S** button: This button engages vertical speed mode. When ON, an ON annunciator illuminates on the button. In vertical speed mode, the plane descends or climbs to an altitude according to a vertical speed (in feet per minute) set in the vertical speed display window. In this mode there autothrottle will try to hold the speed selected in the IAS/MACH display window.

    Note however that there is no direct speed protection: if the autothrottle can't hold the selected speed due to excessive climb or descent rates, the speed will deviate from the selected speed. If a threshold of maximum or minimum speed is crossed, LV CHG mode will automatically engage to dampen the vertical speed to avert an overspeed or stall condition.

    When in vertical speed mode, VS will be displayed on the PFD.

Lateral navigation modes

17. **LNAV** button: This button engages LNAV mode, which stands for Lateral NAVigation. When ON, an ON annunciator illuminates on the button. In this mode, the FMS will take over lateral navigation. It will fly along the route that was programmed into it. As such, it will automatically adjust the heading as necessary to follow the route. But note that any heading changes are not displayed in the heading display window on the MCP.

Pressing the LNAV button when LNAV is already engaged will result in LNAV being disengaged, and HDG SEL mode being engages.

The MA lights above the F/D switches will illuminate to indicate which F/D is handling LNAV. This depends on which A/P is engaged.

A variety of PFD legends may appear when LNAV is armed or engaged:

◊   LNV 1 will be displayed in green when LNAV has captured and is tracking the route, and is provided by F/D 1. If it is displayed in white, LNV 1 is only armed.

◊   LNV 2 will be displayed in green when LNAV has captured and is tracking the route, and is provided by F/D 2. If it is displayed in white, LNV 2 is only armed.

18. **HDG SEL** button: This button engages heading select mode. When ON, an ON annunciator illuminates on the button. In this mode, the crew selects a heading using the heading selection knob, and then presses the HDG SEL knob, and the plane will track the selected heading.

    When heading mode is engaged, HDG will be displayed on the PFD.

19. **VOR/LOC** button: This button engages VOR/LOC track mode. When ON, an ON annunciator illuminates on the button. In this mode, the F/D is instructed to track a VOR or localizer signal along a certain course. The VOR/LOC frequency is set on the NAV 1 and NAV 2 panels, and the course is set using the course selection knobs on the MCP (Figure 41).

    When VOR/LOC mode is engaged, various legends can be displayed on the PFD:

    ◊   VOR 1 will be displayed in green if a VOR frequency that is tuned in the NAV 1 radio is being tracked. If it is displayed in white, VOR 1 is only armed.

    ◊   VOR 2 will be displayed in green if a VOR frequency was tuned in the NAV 2 radio and is being tracked. If it is displayed in white, VOR 2 is only armed.

    ◊   LOC 1 will be displayed in green if an ILS frequency was tuned into the NAV 1 radio and is being tracked. If it is displayed in white, LOC 1 is only armed.

    ◊   LOC 2 will be displayed in green if an ILS frequency was tuned into the NAV 2 radio and is being tracked. If it is displayed in white, LOC 2 is only armed.

    ◊   LOC* will be displayed in green if the same ILS frequency was tuned into the NAV 1 and 2 radios and is being tracked. Note that there is no white (armed) version of LOC*.

20. **GPS** button: This is a fictional button that allows you to easily use the default Flight Simulator GPS with this aircraft. When ON, an ON annunciator illuminates on the button. To use it correctly, you should make sure that a flight plan has been loaded in Flight Simulator. You can do this via the default Flight Simulator flight planner. By doing that, a flightplan is loaded into the default GPS. With this button, the aircraft will fly along the flightplan loaded into the flight planner and default GPS. As such, it works like the plane's LNAV mode, but this way you can skip over the procedure of entering the route into the aircraft's FMS.

Modes not engaged via the MCP

There are some F/D and A/P modes that are not activated from the MCP. Instead, these are activated, for example, from the pilot's yoke. A list of these modes will follow now.

− **Take-Off (TO)**: In TO mode, a variety of other modes are engaged, and as such, TO mode is more a sort of "mixed mode" than a "discrete" mode, which controls only one aspect of automatic flight. When TO becomes active, it does the following:

   ◊ The lateral mode becomes track (TRK) automatically

   ◊ A/T is instructed to hold the speed at V2. It assumes that the pilot sets V2 on the MCP IAS/MACH display window. Any changes to the speed selection in the IAS/MACH window are ignored from 75 knots until a radio altitude of 350 feet, or, if the radio altitude is not accurate or has failed, until 20 seconds after lift-off. Of course, for A/T to do all these things, it must be switched on first

   ◊ There is no vertical mode engaged, except that it gives initial climb directives

There is no TO mode selector. Instead, it is automatically activated in two situations:

   ◊ While on the ground when the F/D is activated

   ◊ When the F/D is activated in the air in the following conditions:

      • The plane is airborne for less than three minutes

      • The plane is below 2000 feet

      • The F/D was disengaged previously

There are various PFD legends for the various TO modes. Note that TO might appear on two places on the PFD: it might appear on the A/T status position, and on the vertical navigation status position. When appearing on the A/T status position, there are the possible legends:

   ◊ A white TO MAX is displayed when TO MAX mode is armed: maximum thrust will be applied on engagement

   ◊ A green TO MAX is displayed when TO MAX mode is active: maximum thrust is applied during the takeoff roll

   ◊ A white TO REDU is displayed when TO REDU is armed: reduced thrust will be applied for a derated takeoff.

   ◊ A green TO REDU is displayed when TO REDU is active: reduced thrust is applied during the takeoff roll

When displayed on the vertical navigation position, only one legend may be seen: a green TO legend to annunciate the activation of Take-Off mode.

– **Track (TRK)**: Track mode holds the current heading. It is only activated during TO and GA modes

– **Flare (FLR)**: This vertical mode is automatically armed and engaged during an autoland. It will flare the aircraft right before touchdown to bleed off speed. FLR will appear on the PFD in white when armed, and it will turn green when engaged

– **Rollout (ROLL)**: This lateral mode is armed when the airplane has touched down after a full autoland. It will keep the aircraft on the centerline of the runway

– **Ground (GRND)**: This vertical mode is armed before touchdown when doing a full autoland. It will engage upon touchdown, and it causes the A/P to slowly lower the nose to the ground and keep it there. GRND will appear on the PFD in white when armed, and it will turn green when engaged

– **Align (ALN)**: In this mode the autopilot aligns with a localizer

– **Retard (RETARD)**: This is an A/T mode in which the thrust levers are fully retarded so that minimal thrust is provided. When activated, a green RETARD legend will appear on the PFD. RETARD mode is used when a LVL CHG descent is initiated or during an autoland flare

Autopilot engage and disengage controls

Figure 44: Autopilot engagement/disengagement controls

These controls enable the crew to engage or disengage the two autopilots. The NAV 1 button (Figure 44, 1) engages A/P 1, and the NAV 2 button (Figure 44, 2) engages A/P 2. When engaged, the associated NAV button will display a white ON annunciation to indicate successful engagement of that A/P. You can engage only one A/P at a time. When A/P 1 is engaged and you press the NAV 2 button, A/P 2 will engage and A/P 1 will disengage.

The emergency disengage bar (Figure 44, 3) disengages both A/Ps and prevents the A/Ps to engage while the disengage bar is pulled down.

Mode Control Panel (MCP) - BAe146

The Mode Control Panel of the BAe146 series looks and works completely different than the one of the Avro RJ.

Figure XX: Autopilot engagement/disengagement controls

As can be seen in Figure XX, the MCP is essentially divided into three parts.
The left third contains the mode selection buttons, which allow you to engage the Autopilot and vertical–, as well as lateral modes.
The center of the MCP contains the Course and Heading selection knobs as well as a so called Navigation Source Selector.
The Altitude selector and an Altitude ARM button are located in the right third of the MCP.

In addition to the MCP, the BAe146 is equipped with an Autopilot Control Panel (AP Control Panel) on the Pedestal. Selected Autopilot Modes are indicated either on the EADI (BAe146-300) or on a Flight Mode Annunciator Panel located on the main instrument panel.

Figure XX: Autopilot Control Panel

Figure XX: Flight Mode Annunciator Panel

It is important to understand that the MCP and the AP Panel are both interconnected and form one unit to control the Autopilot system.
The Autopilot is engaged by selecting "AP" on the MCP or on the AP Control Panel and is indicated by two green triangles and an IN caption on the respective buttons.
If the Flight Director is already engaged, the Autopilot engages in the currently selected Flight Director mode. Otherwise it reverts to the basic modes PITCH and ROLL.

PITCH: Holds the aircraft's pitch angle at the time of AP engagement. This angle can be changed using the PITCH button on the AP Control Panel. Each click represents 1 degrees of pitch change and is immediately indicated by the Flight Director. Do note that due to passenger comfort reasons the plane will need some time to respond.

ROLL: Holds the selected bank angle of the aircraft. The desired bank angle can be controlled using the "ROLL"-knob on the AP Control Panel. It can be adjusted in three steps, being 5, 15 and 35 degrees of bank to each direction.

Other Flight Director- and Autopilot modes are explained on the next pages.

F/D and A/P modes

Figure 44: Autopilot engagement/disengagement controls

All Flight Director– or Autopilot modes are selected directly on the MCP.
The upper row (1-6) contains the selection buttons for vertical modes, while the lower row (7-11) controls lateral modes. When a mode is armed or active, the buttons show two white triangles.
Additionally, the active mode is indicated on the EADI (BAe146-300) or by the Flight Mode Annunciators on the Main Panel (BAe146-200).

1. Glideslope Mode: Is armed by pressing the GSL switch and indicated by a white "GLS" Flight Mode Annunciation (FMA). Once the glideslope is captured, the FMA turns green. Before being captured, the glideslope can be intercepted using any other vertical mode.

2. Altitude Hold Mode: Altitude Hold is used to capture an altitude, which was pre-selected using the Altitude Selector.

    IMPORTANT: For an altitude to be captured, the "ALT ARM"-button next to the Altitude window has to be pressed. It is indicated by a white "ALT" FMA. If the "ALT ARM"-button is not pressed, the plane will NOT capture the pre-selected altitude. As soon as the aircraft reaches the pre-selected altitude, the ALT ARM caption will extinguish and the white triangles on the ALT switch display. The ALT button can also be pressed directly. In this case it will hold the present altitude, regardless of the pre-selected one.

3. Vertical Speed Mode: Maintains the rate of climb or descent at the time of engagement. It is not possible to alter the vertical speed.

4. MACH Mode: Maintains the Mach Number at the time of engagement. It does so by adjusting the pitch angle and NOT by thrust control.

5. VNAV Mode: Without function. Do note that this function is not operative on the real plane, although the button is there.

6. IAS Mode: Maintains Indicated Air Speed at the time of engagement. It does so by adjusting the pitch angle and NOT by thrust control. The reference speed can be adjusted using the speed reference knob (yellow triangle) on the Airspeed Indicator (Main Panel).

7. VOR / LOC Mode: Allows capture of the selected VOR / Localizer radial from ROLL or HDG mode. Do note that the VOR selected by the NAV Source Selector in the center of the MCP will be captured. (NAV1 or NAV2)

8. Back Localizer Mode: Available where backcourse approaches are permitted. Same behaviour as Localizer Mode, except for the reversion of deviation indications on ADI and HSI.

9. Turbulence Mode: Operates the same way as the basic modes PITCH and ROLL, except for:

- Autopilot only mode (FD bars disappear)

- Provides reduced gain commands and thus dampens turbulences (not simulated)

- Is indicated by TURB, PITCH and ROLL captions on the FMA

The only other mode that can be selected is HDG.

10. LNAV Mode: Commands the Flight Director and Autopilot to follow the course on the HSI (set to LNAV) as commanded by the GNS-XLS Flight Management Computer.

11. Heading Mode: Commands the Flight Director and Autopilot to follow the selected heading on the HSI (using the heading selector in the center of the MCP).

3. Engine Instruments, Master Warning Panel and other miscellaneous stuff

Figure 45: The engine instruments and Master Warning Panel, including some other miscellaneous stuff

In the center of the main instrument panel, we find the engine instruments and master warning panel, accompanied by a selection of knobs and levers that control various other things. As such you can split the center part of the main instrument panel itself into three different parts:

− Engine instrumentation (1)

− Master warning panel and other annunciators (2)

− Miscellaneous stuff (3)

3.1 Engine instrumentation

Figure 46: The engine instruments

The Engine instruments can be found somewhat in the center of the main instrument panel. They consist of four vertical rows consisting of eight gauges, depending on what you see as one gauge. Each gauge gives the crew different information on the status of the engines and FADEC. The top-most gauge, which seemingly doesn't belong, is the oil triple display indicator. Below it one may find the FADEC annunciator light, and then follows the Primary Engine Display (PED). At the bottom are some FGS advisory annunciators.

Oil Triple Display Indicator

Shown in Figure 106 in engine 1's oil triple display indicator. The oil triple display indicator is a round gauge that exists for each engine. The gauge holds three small semicircles. Each one is a gauge of its own featuring a numerical range and dial:

−   The upper semicircle shows oil quantity

−   The left semicircle shows oil temperature

−   The right semicircle shows oil pressure

Primary Engine Display (PED)

The Avro RJ has two Primary Engine Displays (PEDs) on the flight deck. Each PED has engine instruments for two engines. The left PED has engine instrumentation for engines 1 and 2, while the right PED has engine instrumentation for engines 3 and 4. As such, on both PEDs you'll find two copies of each type of gauge: one for one engine, the other for another engine. This holds true for pretty much all gauges, except for the fuel gauges at the very bottom, which will be discussed in due course. The four round gauges offer two ways to view the engine's status: by means of an electronic dial and scale bar along which it moves, and a LED display in the center of the gauge. Both display types show the same information, except that the scalebar and dial can easily show if the current status of the engine is within operating limits, and the display offers an accurate assessment of the current value for that specific parameter.

1.   Engine vibration: shows the associated engine's vibration

2.   N1SET: shows the maximum N1 value set for that engine

3.   N1: shows the current N1 value of that engine

4.   EGT: shows the current temperature (EGT) of that engine

5.   N2: shows the current N2 value for that engine

6.   FF/FU: Shows the current fuel flow (FF) for that engine, or, when the FUEL USED button (Figure 108, 9) is pressed, shows the fuel used (FU) instead

7.   FUEL QTY: Shows the quantity of fuel still available in each of three storage tanks. There are three fuel quantity indicators, not four. On the left PED you can find the fuel quantity indicators for the left wing (L WING) and center (CTR) tanks, and on the right PED you can find the fuel quantity indicator for the right wing (R WING) tank

Furthermore there are several buttons along the bottom and left and right edges of the PEDs:

8.   N1 bug set knobs: these knobs are available for each separate engine. They allow you to manually set the N1 reference bug. Right click the knob to pull it out and activate manual N1 bug reference mode. This will be indicated by a preceding "M" in the N1SET window. Use the mousewheel to adjust your N1 bug.

9.   FUEL USED button: changes the fuel flow (FF) indicator into a fuel used (FU) indicator. After 10 seconds the indication goes back to fuel flow again.

10. RESET button: resets the amount of fuel used to zero

FGS advisory annunciators

There are two or three annunciator lights below the PED. The QualityWings Ultimate 146 Collection simulates two FMS CDUs, so you'll find that there are three FGS annunciator lights instead of two. The annunciator lights are as follows:

−   **FGC 1**: Annunciator illuminates to indicate that there is a fault within FGC 1

−   **YD 1**: Annunciator illuminates to indicate that yaw damper 1 has failed

−   **FGC 2**: Annunciator illuminates to indicate that there is a fault within FGC 2

−   **YD 2**: Annunciator illuminates to indicate that yaw damper 2 has failed

−   **NO CAT 3 LAND**: This annunciator light illuminates to signal that an automatic category 3 landing is not possible

3.2 Master Warning Panel and other annunciators

Figure 47: The Master Warning Panel and several other indicators

Besides the flap indicator, roll spoiler indicators and gear position indicators, this part of the main in-strument panel is completely devoted to the central warning and central status panels. These are pan-els filled with annunciators that tell the pilot what has gone wrong, or at least indicate in what system a fault has occurred. In the latter case, the crew will be able to find the exact problem on, for example, the related overhead subpanel.

Flap indicator

The flap indicator shows all of the flaps' positions. There are five indications on the flap indicator, each corresponding to the associated detent of the flaps lever on the throttle quadrant. The five detents are UP, 18, 24, 30 and 33. These indications have been placed around the outer edge of the flap indicator in such a way that they display the relative distances between the flap positions.

Left and right roll spoiler indicator

The roll spoiler indicators, positioned to the right of the flap position indicator, show the positions of the left and right roll spoilers. The roll spoilers are control surfaces on the wings that aid in a roll maneuver by deploying together with the ailerons. The position indicators in the cockpit indicate their exact position. On, a range of 0 to 10 degrees deployment is shown, with specific positions of 0, 5 and 10 degrees displayed on the gauge. The roll spoiler can take any position between 0 and 10 degrees, however.

Gear position lights

The gear lights, found under the roll spoiler gauges, are three pairs of red/green annunciators. The left light indicates the left main gear position, the middle the nose gear position, and the right light the right main gear position. When green, the associated gear elements are down and locked. When red, they are retracting. When no annunciator is on, they are up and locked.

Central Warning Panel (CWP)

Figure 48: The Central Warning Panel (CWP)

The central warning panel is the crew's portal into the aircraft systems' logic. It provides a "bird's eye view" into any misconfigurations, problems and failures that might have occurred on any of the plane's systems. The result is blackness if everything operates okay, or a sea of warning lights if there are problems. Even though it may seem like a mess of annunciators, it is not. Even this seeming chaos has some logic in it.

One can divide the CWP in three sections. The first section comprises the upper seven rows, and these are concerned with engine related failures and faults. The second section are the five layers below the "double striped" row of annunciators, which are annunciators that draw attention to specific overhead panels. These double striped annunciators are basically inactive and can be ignored at all times. The last section is the rest, and it contains all kinds of annunciators.

The second section, the one containing overhead panel attention getters, follows a simple logic: one of available space. All of these annunciators show a system's name together with an arrow pointing upward. This arrow denotes "look up". Basically, what the annunciator says is, that you should look at that specific system's overhead subpanel. It means that a problem ahs occurred inside that system, and that annunciators on the system's overhead subpanel have illuminated. To get the crew's attention, a separate annunciator denoting this event has been placed on the CWP.

There are four categories of annunciators on the CWP: red, high category amber, normal category amber and white fault. Depending on which category the illuminated annunciator is in, it will trigger the red or amber attention getters on the glare shield and an audio warning may also be heard. Now follows a description of the annunciators on the CWP.

ENG 1/2/3/4 FIRE HANDLE
> *Annunciator denotes that associated engine's fire handle is pulled out (not simulated)*

ENG 1/2/3/4 FIRE
> *Annunciator denotes that the associated engine is on fire*

LOOP 1/2/3/4 FAULT
> *Annunciator denotes that the associated engine's fire warning loop is faulty*

PYLON 1/2/3/4 OVHT
> *Annunciator denotes that warm air from the engine's compressor is leaking out of the bleed system and causing overheat conditions in the associated engine's pylon*

OIL 1/2/3/4 LO PRESS
> *Annunciator denotes that a low oil pressure has been detected for the associated engine*

FUEL 1/2/3/4 LO PRESS
> *Annunciator denotes that a low fuel pressure has been detected at the associated engine*

FILTER 1/2/3/4 CLOGGED
> *Annunciator indicates that the high or low fuel filter in the associated engine's fuel feeding system is clogged (see also Figure 66)*

APU FIRE
> *Attention getter denoting that the an APU fire has been detected and immediate action from the overhead panel is needed*

ELECT SMOKE
> *Annunciator indicating that smoke was detected in the electronics bay*

ANIMAL SMOKE
> *Annunciator denoting that smoke was detected in the animal bay*

CONFIG
> *Annunciator indicating that the plane is not in the take-off configuration, even though take-off power was applied via the thrust lever*

FLAP INOP
> *Annunciator denotes that the flaps are inoperative*

CABIN HI ALT
> *Annunciator indicates that the cabin altitude exceeds a preset value*

ENG VIBN
> *Attention getter denoting that the engine vibration is too high, and directs the crew to look at the engine vibration gauge on the PED, which is to the left of the CWP (Figure 108)*

ENG OVSPD

> *Annunciator indicates an overspeed condition in one of the engine, but is not specific which engine overspeeds. For this the engine instruments should be inspected*

APU

> *Attention getter denoting a problem with the APU, and directs the crew to the APU overhead subpanel*

STALL IDNT

> *Annunciator indicates that one of the stall protection IDENT lights has illuminated*

ANTI SKID

> *Attention getter denoting a problem with the anti skid, and directs the crew to the anti skid overhead subpanel*

SPLR

> *Attention getter denoting a problem with the lift spoilers, and directs the crew to the lift spoiler overhead subpanel*

ICE PROT

> *Attention getter denoting a problem with the ice protection system, and directs the crew to the ice protection system's overhead subpanel*

AIR COND

> *Attention getter denoting a problem with the air conditioning system, and directs the crew to the air conditioning system's overhead subpanel*

HYD

> *Attention getter denoting a problem with the hydraulics system, and directs the crew to the hydraulic system's overhead subpanel*

FUEL

> *Attention getter denoting a problem with the fuel system, and directs the crew to the fuel system's overhead subpanel*

ELECT

> *Attention getter denoting a problem with the electrical system, and directs the crew to the electrical system's overhead subpanel*

AIR SUPPLY

> *Attention getter denoting a problem with the air supply system, and directs the crew to the air supply system's overhead subpanel*

RUDDER LMTR

> *Annunciator denoting that the rudder pedal limiter has not come back to the approach position when the aircraft is on the approach*

CAB DOOR NOT SHUT

> *Annunciator indicating that one or more of the cabin doors are not shut*

WING NOT DE-ICED

> *Annunciator indicating that one or more of the wings have not been cleared of ice. It will illuminate when the flaps are set to 18 degrees, OUTER WING ANTI-ICE is set to ON, but INNER WING DE-ICE is set to OFF*

ICE DETECTED

> *Annunciator denoting that ice was detected on the airframe*

RUDDER VALVE

> *Annunciator indicating that there has been a fault in one of the hydraulic rudder actuators*

LIFT SPLR SEL OFF

Annunciator denoting that either one of the left spoiler switches on the overhead panel has been set to OFF

RUD/EL Q FAIL

Annunciator denoting that the static pressure of the two Q-pots is either too low or too high

AIL/EL UNCPLD

Annunciator indicating that the ailerons and elevators are uncoupled

FLAP FAULT

Annunciator indicating that there is a fault in the flap system. They may move too fast, too slow or not at all

LWR DOOR NOT SHUT

Annunciator indicating that one or more of the cargo bay doors are not closed

EMERG LTS NOT ARMED

Annunciator denoting that the emergency lights haven't been armed

OVHD DIM FAIL

Annunciator indicating that there is a problem with the overhead light dimming circuit

FADEC

Attention getter alerting the crew to a problem with one or more of the engine's FADECs and directing the crew to the engine instruments, to the left of the CWP

CAB DOOR FAULT

Annunciator indicating that one or more cabin doors' opening and closing system logic has lost power

MWS DIM FAIL

Annunciator denoting that the Master Warning System's dimming circuit has failed, which prevents one or more annunciators on the CWP from illuminating

IRS DC BACKUP

Annunciator indicating that the IRS is being powered by DC backup power

PARK BRK ON

Annunciator indicating that the parking brake is ON

ELT

Attention getter alerting the crew to a problem with the Emergency Locator Transmitter and directing the crew to the relevant panel

MWS FAULT

Annunciator indicating a problem with the Master Warning System's attention getting, which is provided by audio warnings and glare shield attention getting lamps

Central Status Panel (CSP)

Figure 49: The Central Status Panel (CSP)

The Central Status Panel (CSP), is a smaller panel under the CWP, alerting the crew to the status of systems. Unlike the CWP annunciators, the CSP annunciators denote lower profile problems, but also whether ice protection is ON or OFF, for example.

There are several categories of annunciators on the CSP. First of all, there are white annunciators and green annunciators. The green annunciators are status annunciators. The white annunciators can be divided into white status annunciators and white fault annunciators. Which white annunciator is what, is however not readily apparent. Now follow descriptions of each of the annunciators on the CSP.

AUTO SPLR OFF
> *Annunciator illuminates if the AUTO SPLR switch on the overhead panel is set to OFF*

GPWS INOP
> *Annunciator indicating that the ground proximity warning system is inoperative*

WINDSHR INOP
> *Annunciator indicating that the windshear detection system is inoperative*

FLT REC OFF
> *Annunciator denoting that the flight recorder is turned OFF*

FUEL FEED OPEN
> *Annunciator illuminates when either one of the common feed or the cross feed valve is fully opened*

FUEL TRANSFER
> *Annunciator indicates that a center tank fuel transfer valve is open, or that there is fuel in one of the auxiliary tanks*

SCRN HEAT SEL OFF
> *Annunciator illuminates when the SCRN HEAT switch is set to OFF*

EMERG LTS ON
> *Annunciator indicating that the emergency lights are turned ON*

AIR SEL ON GRND
> *Annunciator illuminates when the aircraft is on the ground and either engine air 1, 2 or 3 is ON. It does not illuminate when engine air 4 is ON*

EXT PWR NOT SHUT
> *Annunciator illuminates when the external AC's power door is not shut*

BRK FANS SEL ON
> *Annunciator illuminates when the brake fans are ON. This happens when the BRK FANS switch is set to ON, or the switch is at AUTO and the nose gear is down and locked*

ENG IGN ON
> *Annunciator illuminates when either one of the two CONT IGN switches are set to ON*

ENG A ICE ON
> *Annunciator illuminates when engine anti-ice is turned ON*

WING/TAIL A ICE ON
> *Annunciator illuminates when wing or tailplane anti-ice has been turned ON*

3.3 Miscellaneous stuff

Figure 50: Right most part of the center main instrument panel

The right-most part of the center main instrument panel, has a variety of stuff included in it. The gear lever features prominently, but there's also an interactive speedcard and the TRP amongst other things. Each will be dealt with separately.

EGPWS and stall detection system annunciators

To the right of the gear position lever, there are several annunciator lights. The IDNT 1/2 and INHIB annunciators are related to the stall detection system. These are not simulated in this product.

The 24, 33, S.APP (white) and S.APP (green) annunciators are related to the EGPWS system, which monitors distance to terrain and potential conflicts with terrain.

24

> *When the "24" annunciator is lit, the 24 degree flap setting is the trigger for the "gear not down" warning if the gear is indeed not down and locked*

33

> *When the "33" annunciator is lit, the 33 degree flap setting is the trigger for the "gear not down" warning if the gear is indeed not down and locked*

Press this button to toggle between your desired landing flap position.

S.APP

> *Steep approach mode is armed. In steep approach mode, some EGPWS functions are desensitized to inhibit nuisance warning during particularly steep approaches (such as in mountainous terrain would be the case).*

S.APP

> *The green steep approach annunciator will illuminate when steep approach mode is active*

Press this button to arm the steep approach mode. Note that arming steep approach will automatically set the landing flap position to 33.

Speedcard
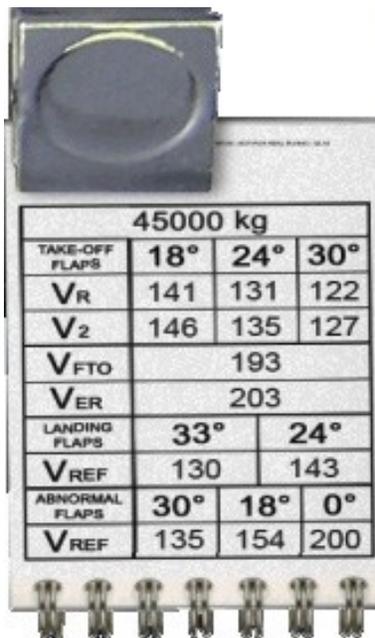
45000 kg			
TAKE-OFF FLAPS	**18°**	**24°**	**30°**
V_R	141	131	122
V_2	146	135	127
V_{FTO}	193		
V_{ER}	203		
LANDING FLAPS	**33°**		**24°**
V_{REF}	130		143
ABNORMAL FLAPS	**30°**	**18°**	**0°**
V_{REF}	135	154	200

During take-off and landing, there are several standard speeds that are important for correct operation of the planes. The speedcard will help you pick the right speeds for both take-off and landing, based on the plane's current weight.

V_R Rotation Speed. Slowly pull the Yoke towards you and lift the nose to get off the ground

V_2 Take safety speed. This is the speed for your initial climb and ensures that your aircraft safely becomes airborne, even with one engine inoperative.

V_{FTO} Final Take Off speed. This means the speed of the airplane at the end of the take off path. Make sure you retract your flaps when reaching this speed

V_{ER} En-route speed. This is the best speed to continue your climb in order to achieve the best climb performance

V_{REF} Reference Landing Speed. This should be your speed on final approach.

Thrust Rating Panel (Avro RJ)

The Thrust Rating Panel (TRP) is a small panel to the right of the speedcard. It provides control over the maximum thrust settings for the engines for use with autothrottle.

This control is given by means of three thrust rating buttons: TOGA, MCT and CLIMB.

By pressing the buttons, a maximum N1 is set by which the autothrottle will abide.

For example, when climbing, the autothrottle will never use a higher thrust rating than what is set on the TRP. To make sure that this works correctly however, you will have to make sure that the TRP has always been set to the correct thrust rating for each flight phase.

Use TOGA for Take-Off and Go-Around situations. The TOGA button has two green annunciators.

TOGA MAX   *This is the standard setting for take-off and go-around, and the TRP will default to it upon TOGA selection. It provides maximum thrust.*

TOGA REDU   *REDU stands for reduced, and is used for a derated take-off, but usually not for go-around situations.*

Switch between them by pressing the TOGA button.

The idea of a derated takeoff, is that you use a lower thrust setting. Maximum thrust isn't always necessary, for instance when the aircraft isn't fully loaded and you can get the same take-off and climb performance with a lower thrust setting. Plus, using a lower thrust setting, you can conserve fuel and decrease wear and tear on the engines, leading to a longer operational life cycle. Using the TRP, you can manually set a lower thrust rating. To do this, you don't change the thrust rating, but you set a higher outside air temperature (OAT).

Why set a different OAT, and not just change the thrust setting itself? The system logic calculates the required N1 thrust setting by using the OAT. While it may seem strange, it's rather logical. The N1 setting not only sets a max thrust setting, it's also a protection for the engines: a protection against overheat conditions. With a high OAT, the engines are much more prone to overheat conditions, and as such the N1 setting is lower. The crew may use this "way of thinking" of the system to manipulate it into believing that the OAT is higher than it actually is by selecting their own OAT on the TRP. This can be done by using the two concentric knobs below the three thrust rating buttons. See below for a description of these concentric knobs.

MCT   MCT stands for Maximum Continuous Thrust and is the maximum thrust the pilot can expect to get from the engines for a longer period of time. As such it provides a barrier, above which the engines may get damaged. The most important information the crew can derive from the MCT rating, is the thrust the remaining engines will provide when one of the engines fails. If the remaining engines fall short on their MCT rating, then the aircraft can't be considered airworthy.

Use CLIMB during climbs. Like TOGA, it has two green annunciators on a toggle switch.

CLIMB NORM   *This is the normal thrust rating for climbing and will be used most often*

CLIMB MAX   *This provides maximum thrust for climbing, which results in more wear and tear of the engines, plus a higher fuel burn rate. Only use CLIMB MAX for emergency or dangerous situations where you need to avoid terrain or other aircraft quickly. Otherwise CLIMB NORM will almost always suffice*

Below these three buttons, there are two concentric knobs. These are used to manually set a temperature and three speed bugs on the EFIS displays.

The outer knobs moves in "clinks", and controls the display of parameters on the LCD screen of the TRP. The options are N1, TEMP and three speed bugs.

The inner knob allows you to change the currently displayed parameter, although N1 can *not* be changed! Only TEMP and the three speed bugs can be changed. This is in fact how you control a derated takeoff. Use the outer knob to select TEMP, and then rotate the inner knob to a higher temperature to select a derated takeoff.

Rotate the outer knob to V_1 and click the inner knob to adjust the speed. The V_1-speed will appear in magenta on the speedtape of our Primary Flight Display.

Select V_{CROSS} and set the speed to V_R from the speedcard next to the TRP. The speedcard will always show the correct speeds depending on your aircraft's weight.

Select V_{DOT} and set the speed to V_{FTO} from the speedcard next to the TRP. V_{FTO} is the speed where you should retract your flaps.

Thrust Modulation System (BAe146)

The Thrust Modulation (TMS) System on the BAe146 provides the ability to:

◊   Fine tune thrust to enable a flexible or reduced take-off

◊   Ensure a minimum thrust descent

◊   Synchronize N1 or N2 of all engines to that of a selected master engine

◊   Synchronize Turbine Gas Temperature (TGT) to a pre-selected temperature

It does so by means of an actuator which is positioned between each thrust levers and the Fuel Control Unit. The latter directly controls the amount of fuel supplied to the engine and thus the thrust.
The Figure below illustrates the architecture:
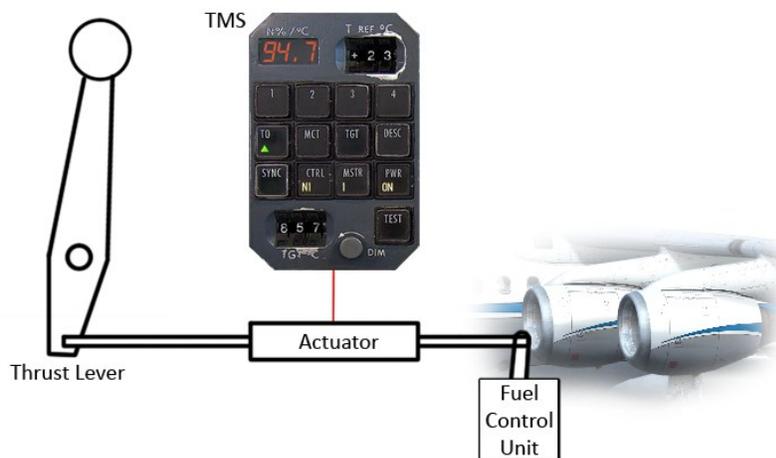
The Figure shows the actuator in the central position. The TMS sends commands to extend or retract to each actuator. This way the thrust can be adjusted without any movement of the thrust levers.
The authority of the TMS is limited by the length of the actuator's stroke. If the end of the travel is reached, small arrows on the TMS control unit on the main panel will indicate that the thrust levers have to be moved for the required thrust setting to be in range of the actuator's travel.
See the Figure below:

TMS Control Unit
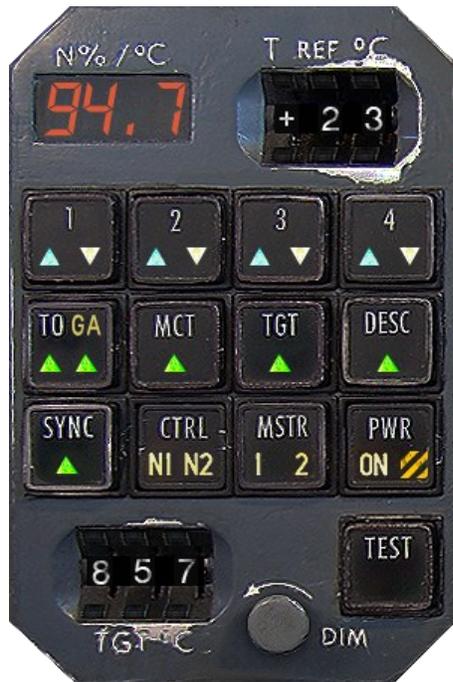
The TMS control unit consists of a LED display, showing the reference N1 percentage or the target TGT depending on the mode selected. The first row is fitted with annunciators indicating small arrows to move the thrust levers.

There is a blue up-arrow and a white down-arrow for each engine. They illuminate to indicate that the end of the TMS actuator travel is reached and thus a thrust lever movement towards the desired reference N1 or TGT is required.

There are five distinctive modes that can be selected, being:

◊ Take-Off mode

◊ Maximum Continuous Thrust mode

◊ Synchronization mode

◊ TGT mode

◊ TGT/Synchronization mode

◊ Descent mode

Take-Off mode

Pressing the TO button cancels any other selected mode and displays a green arrow on the TO button. Similar to the Avro RJ's TRP, the "T REF °C"-thumbwheel in the upper right corner allows the ambient temperature to be set for the calculation of the reference N1 value. Selecting a higher temperature will allow for a de-rated Take-Off. The resulting reference N1 will be displayed in the LED window.

Do note that a take off with ENG AIR selected ON is prohibited in case any of the following switches are selected ON:

◊   OUTER WING or TAIL ANTI-ICE

◊   INNER WING DE-ICE

◊   PACK 1 or PACK 2

An invalid selection will be indicated by a flashing reference N1 value in the LED window.

Maximum Continuous Thrust mode

Pressing the MCT button cancels any other selected mode and displays a green arrow on the MCT button. Upon selection, the MCT mode gives a reference N1 value for the maximum attainable continuous thrust.

The following limitations will not be exceeded:

◊   TGT of 857°C

◊   N1 of 96.7%

◊   N2 of 96.9%

Synchronization mode

Except for TGT mode being active, pressing the SYNC button cancels any other selected   mode and displays a green arrow on the SYNC button. This mode synchronizes the N1 or N2 of three engines to that of a master engine. Whether N1 or N2 shall be synchronized can be toggled by pressing the CTRL button in the lowest row of buttons on the control unit. Next to this, the button to select the master engine is located. It allows for either engine 1 or 2 to be the master. The three other engines are regarded as slave engines. The actuator of the master engine will remain neutral, while the slave engines' ones extend or retract in order to synchronize to the master engine's N1 or N2.

TGT mode

Pressing the TGT button cancels any other selected mode and displays a green arrow on the TGT button. This mode synchronizes the Turbine Gas Temperature (TGT) of all engines to the one selected using the thumbwheels in the lower left corner of the control unit. In addition, the selected temperature is shown in the LED window. A limit of 857°C cannot be exceeded.

TGT/Synchronization mode

When TGT mode is active, pressing the SYNC button enables TGT/SYNC mode and indicates green arrows on both, the TGT and the SYNC button.

This mode synchronizes the N1 or N2 of the three slave engines to that of the master engine.

Additionally, the master engine's TGT is synchronized to that set by using the thumbwheels.

Descent mode

Pressing the DESC button cancels any other selected mode and displays a green arrow on the DESC button. The function of this mode is to allow a minimum power descent whilst supporting any engine bleed air load. It does so by providing a minimum N2 for the actual altitude and bleed air configuration. The white up-arrows will illuminate if the minimum N2 values are not reached.

The minimum N2 during a normal descent is:

◊   At or above 25 000ft: minimum 70% N2

◊   Between 25 000ft and 20 000ft: minimum 65% N2

◊   Below 20 000ft: minimum 60% N2

During icing conditions, the minimum N2 is calculated as follows:

◊   72% + 2% per 5000ft altitude

With Descent mode engaged, the TMS automatically switches to Go-Around mode when descending through 200ft radio altitude.

QUAD indicator

The QUAD indicator is a four-line LCD display that shows pressurization information. It is also known as the pressurization indicator. The data displayed is supplied by the pressurization system.

The first line shows the current cabin rate in feet per minute (FPM)

The second line shows differential pressure in psi

The third line shows the cabin altitude in feet (FT)

The fourth line shows the landing altitude in feet (FT)

THE PEDESTAL

The Pedestal in the Virtual Cockpit

The pedestal is a place where you'll find a large variety of panels. It is not a system hub like the over-head panel, nor is it a place where you'll find vital instrument indications. The pedestal houses three things:
-The Flight Management System,
-The Throttle Quadrant
-The radio stack

In this chapter we will look at the throttle quadrant and radio stack. The flight management system has its own chapter.

THE THROTTLE QUADRANT
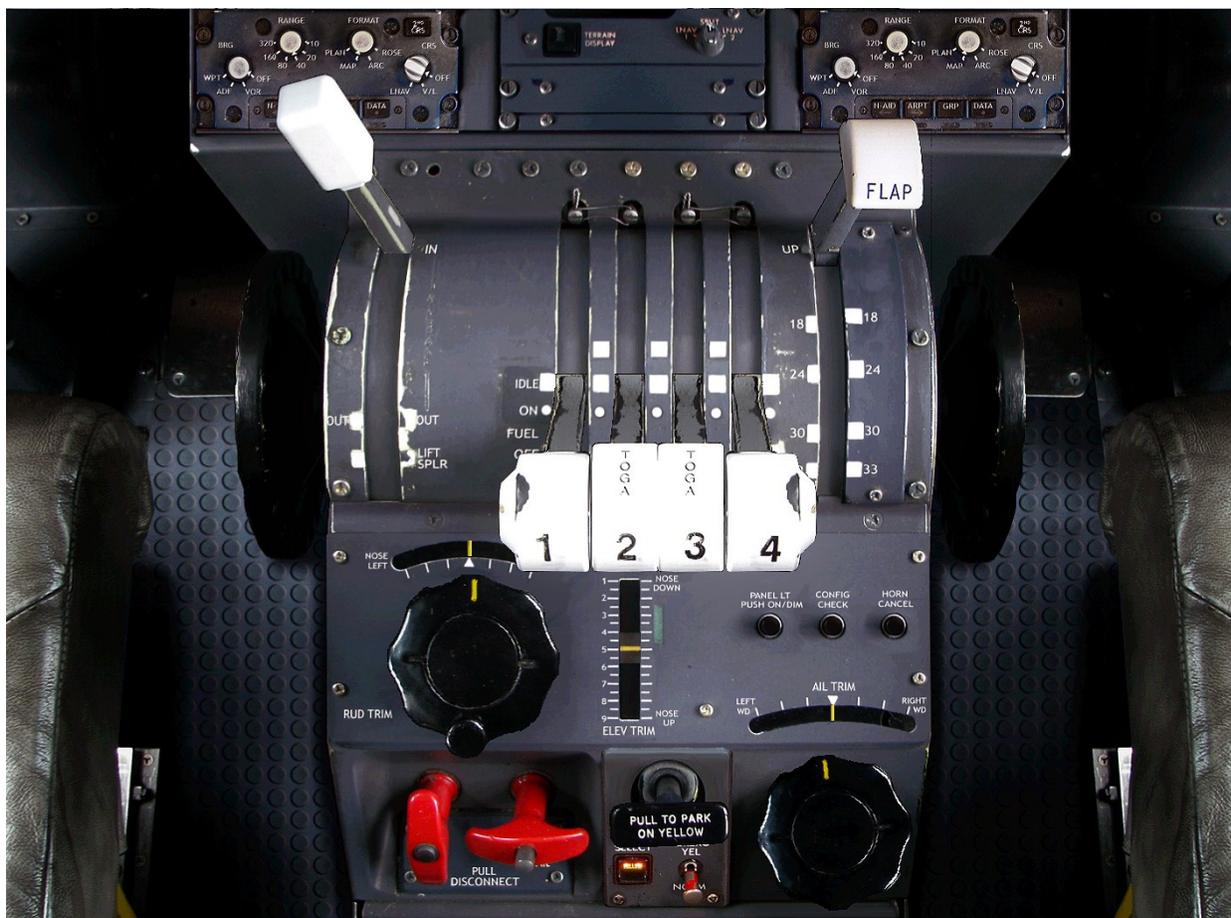
Figure 50: Throttle Quadrant in the 2D Panel (Shift+4)

Trim Controls
There are Trim Controls for all three main control surfaces, meaning elevator, aileron and rudder. The elevator trim wheels are discs, which are placed on both sides of the throttle quadrant. You can trim the elevators by turning them clock– or counter clockwise. The rudder and ailerons can be trimmed by turning the black smaller wheels labeled as "RUD TRIM" respectively "AIL TRIM" in the direction you want to trim. There is a trim indicator for every trim control.

Airbrake / Lift Spoiler Lever

The combined airbrake/lift spoiler lever is a single lever to the left of the four thrust levers. With it, you can control the lift spoilers (Figure 51, green and yellow tinted surfaces) and airbrake (Figure 124, red tinted surfaces). The airbrake/lift spoiler lever has three detents, or fixed positions:

IN   lift spoilers and airbrake are fully retracted at this position. This is the normal position during most stages of flight.

OUT   Airbrakes are fully deployed, but lift spoilers are retracted in this position.

LIFT SPLR   In this detent the lift spoilers are deployed.

You can freely move the airbrake/lift spoiler lever between the IN and OUT detents for a varying range of airbrake deployment.

Contrary to many airplanes, where the airbrake and spoilers tend to be combined into the same control surface, the BAe146 Series has a different arrangement. The airbrakes and lift spoilers are different control surfaces: the airbrakes are extended laterally and can be found at the very back of the plane. The lift spoilers are what normally would also function as airbrakes on most aircraft, and these can be found on the top surface of the wings. See Figure 51. However, they are all controlled using the same airbrake/lift spoiler lever, namely the lever discussed here. Between the IN and OUT detents, the airbrake is activated; at the LIFT SPLR detent, the airbrake and lift spoilers are activated.

Figure 51: Lift spoilers (green/yellow) and airbrake (red) positions. The green/yellow colors on the lift spoilers signify the hydraulic system by which they are powered.

Thrust Levers

There are four thrust levers, one for each engine. All four thrust levers work in the same way: move the lever forward increases engine thrust, moving it aft, decreases engine thrust.

Important Note:
There are no Fuel Cut-off-Switches on this aircraft!
You cut off fuel, by moving the thrust levers into the FUEL OFF detent, which is actually even below IDLE. In order to do so, **right-click below a respective thrust lever to cut off fuel.**

Flaps Lever

The flaps lever is the right-most lever on the throttle quadrant. It lets the crew control the degree of flaps that is deployed, and is used during take-off and landing. During take-off, flaps are used to increase lift and enable slower take-off speeds. The same applies to the landing, although the degree of flap deployment is much higher, resulting in additional drag. The flaps lever has five detents, one for each flap position: UP, 18°, 24°, 30° and 33°

Parking Brake Handle

The Parking Brake Handle controls the parking brake. Pull it out to set the parking brake and push it in to release the parking brake. The "PULL TO PARK ON YELLOW" text means that the yellow hydraulic system will be used to power the parking brake.

THE RADIO STACK

Figure 52: Radio Stack in the 2D Panel (Shift+5)

VHF / HF Boxes

The Avro has two VHF/HF Boxes for Air Traffic Control Communication. The Left LCD Window shows the current active frequency. It is not possible to change this frequency directly. The right LCD Window shows a preselected frequency. You can change this frequency, move your mouse over the frequency and adjust using the appearing +/- Cursor. Once you have dialed in the correct frequency, hit the transfer button between the LCD Windows. This will swap the two frequencies and make the PRESELECT frequency your new ACTIVE frequency.

ADF Box

ADF stands for Automatic Direction Finder and is a navigational system. The crew may tune the frequency of a nearby ADF station, and use the readings on the DBI or EHSI to fly towards to ADF station or calculate their present position using the ADF station's signal. The Ultimate 146 Collection has a dual ADF Controller installed, which allows you to tune two ADF frequencies at a time. To adjust a frequency, just move your mouse over the frequency window and adjust the value using the +/- Cursor.

Additionally we find two BFO switches. BFO stands for „Beat Frequency Oscillator" and generates an audio tone to let you identify beacons that identify themselves using interrupted-carrier keying. This function is not simulated by Microsoft Flight Simulator.

TCAS / Transponder

The box displayed controls both, the Traffic Collision Avoidance System (TCAS) and the aircraft's transponder. Three modes are simulated in the Ultimate 146 Collection and can be controlled using the big rotary knob below the LCD Window.

STBY   Standby. The Transponder and TCAS are OFF and in standby mode.

XPNDR   Only the Transponder is active and transmitting.

TA/RA   Transponder and TCAS are active. TCAS alerts you of traffic that is close by and gives you advisories in order to avoid traffic.

The transponder is a system not entirely unrelated. From ATC you will receive squawk codes (1200 for VFR flights, something else for IFR flights), which have to be input into the transponder. The code that is input and active can be seen on the LCD window. To change the code, move your mouse on the LCD window and adjust the value using the +/- Cursor.

NOTE FOR SQUAWKBOX / FSINN USERS:

The file "sb3gaugebridge.dll" is needed for the Transponder to work correctly with Squawkbox / FSInn. Make sure you have it in your /Modules Folder.

BTI (Brake Temperature Indicator) - Avro RJ
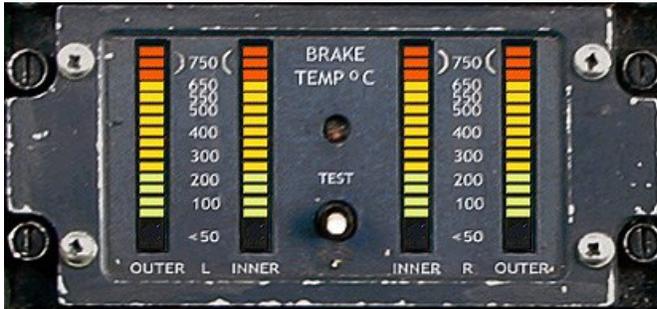
The Brake Temperature Indicator (BTI) shows the temperature of the brakes located on the main landing gear. The two indicators on the left show the brakes for the left outer and inner wheels of the main landing gear, the two indicators on the right show the brake temperature for the right outer and inner wheels of the main landing gear.

Each strip has numbers along either one of its sides. The range above 650 degrees can be considered critical and usually needs further aircraft inspection. Try to avoid brakes getting hot whenever possible. You can test the proper BTI function using the TEST-button in the middle.

BTI (Brake Temperature Indicator) - BAe146

The Brake Temperature Indicator (BTI) shows the temperature of the brakes located on the main landing gear. The two indicators on the left show the brakes for the left outer and inner wheels of the main landing gear, the two indicators on the right show the brake temperature for the right outer and inner wheels of the main landing gear.

Pedestal Lighting Controls

The Pedestal Lighting Controls can be found at the very aft portion of the pedestal

FWD CONSOLE   toggles lighting of the forward portion of the pedestal (FMS and throttle quadrant)

AFT CONSOLE   toggles the lights of the aft portion of the pedestal (the radio stack)

CONSOLE FLOOD   toggles the floodlighting of the entire console. This is not simulated.

The switch to lock / unlock the flightdeck door serves no purpose in this product.

THE AUDIO PANEL

The Audio Panels in the Virtual Cockpit

The Audio Panel is a panel that encompasses more than just the audio panel. It also holds the IRS selectors and some lighting controls, which all will be discussed in due time.

The 2D Audio Panel (Shift+7)

IRS Panel (MSU)

The IRS, or Inertial Reference System, is a system that gives situational awareness to the aircraft's systems. It uses inertia as reference to where it is and where it is going. It consists of an Inertial Reference Unit (IRU) and a Mode Select Unit (MSU). The MSU is the panel fitted on the First Officer's Audio panel. The IRU is a system not visible to the crew, but is controlled via the MSU. Together, they are called the IRS.

The MSU allows you to turn the two IRU units OFF or set them to NAV using the two knobs. The other positions are not simulated. At OFF, the associated IRU is turned off. At NAV, it will align if it is not already aligned, and afterwards it will function normally. The two annunciators above the two knobs illuminate if the associated IRU unit is not in its navigational (NAV) mode

It is important that the plane does not move at all while the IRS units align. The Alignment time on The Ultimate 146 Collection is set to 10 seconds by default, but can be customized via the QualityWings Config options.

Audio Selector Panel

The audio selector panel (ASP) is a panel that allows the crew to make communication and navigation equipment audible. For the VHF and HF radios this generally means hearing what ATC and other aircraft say, and for the other radios, including ADF, DME, VOR and ILS signals, this generally means Morse code by which the station can be identified. The BAe 146 series has historically known two types: one incorporates PA and Service Intercom selectors and the other doesn't. The one fitted in this product is of the latter sort.

On the audio panel there is a marked difference between facilities that allow you to transmit and receive and those that only allow you to receive. Those that allow transmitting have a transmit facility selector. These are the VHF and HF radios. These are the top row of buttons. Only one transmit selector can be selected at a time, allowing you to only transmit over one channel at a time. On The Ultimate 146 Collection the selected transmit selector automatically toggles the receiver as well. You will always receive the frequency you transmit on.

It is possible to receive the following signals:

VHF1 / 2

MKR

DME1/2

VOR1/2

ADF1/2

Main Panel Lighting Controls

The main panel lighting controls can be found under the audio selector panel on the left side of the captain's seat and right side of the first officer's seat.
The following lights can be controlled in this product:

PANEL FLOOD   The panel flood light switches allow to turn the main instrument panel floodlights ON. These lights are dimmable in the VC. In the 2D Panel, Flood lights are not operative.

PANEL INSTS   These switches allow the crew to turn on the instrument lights on the left and right main instrument panel and left and right console.

—INTENTIONALLY LEFT BLANK—

FLIGHT MANAGEMENT SYSTEMS

The BAe146 / Avro RJ Series has always known multiple Flight Management Systems (FMS), of which the GNS-XLS and Collins FMS (GNLU 910) are modelled in the Ultimate 146 Collection.

There are two parts to an FMS: The FMS itself and the CDU/MCDU. The FMS is the actual computer that handles the input data and requests. CDU/MCDU stands for: Control Display Unit. Whether it is called CDU or MCDU depends on the type of FMS you are using, but in the end it's a slightly different terminology for basically the same piece of equipment: a computer display with buttons that enables the pilot to access and manipulate the FMS's functioning.

Collins FMS (GNLU910) - Avro RJ Series

Honeywell GNS-XLS - BAe146 Series

THE COLLINS FMS (GNLU 910)
General CDU Layout

The CDU is characterized by its big display screen, which takes up the approximate top half of the CDU panel. Generally we can find three kinds of buttons on the CDU:

Display Selector Keys
The *display selector keys* enable the user to access a set of pages. Once on a page, then one can flip through the pages using the PRV and NXT buttons, found under the bottom left corner of the display.
Line select keys

Line Select Keys (LSKs)
The line select keys are used to insert data onto an associated line, or to copy data of that line onto the *scratchpad*. The scratchpad is a blank area at the bottom of the CDU display where typed entries appear. These entries can then be inserted onto a line using the line select keys. The line select keys are numbered by position. Line select keys on the left of the display are numbered LSK L1 – L6, 1 being the top-most key, and L6 the bottom-most key. The line select keys to the right of the display are numbered LSK R1 – R6, via the same method as the left keys. So, when you read LSK R5, then the line select key that is positioned on the right side of the display, fifth from the top, is meant.

Alphanumeric Keypad
The alphanumeric keypad is used to enter information into the scratchpad. The scratchpad is a blank area at the bottom of the CDU display where typed entries appear.

CDU Page Layout

The CDU's page layout is reminiscent of other CDU page layouts, and as such you won't have a hard time understanding the interface of the GNLU 910 if you have worked with FMS CDUs before. Below, you see the first page of the route section (RTE). It shows the active flight plan. We will use this page in order to describe the layout.

A page in the GNLU 910 is made up of four distinct areas.

Page Header
Here you will find the page title and page number. If appropriate, it may also display "ACT", which denotes that the information on the page is activated and will be used in further FMS calculations.

Central Information Area
Here it is where all actual information is displayed, and where modifications of the data can be done. It will vary between pages what exactly is displayed here, but there are some general regularities:
- Small letters denote a line's title. For example, the first line's title is ORIGIN.
- Normal-sized letters are data entries. In this case "LOWI" is such a data entry.
- Boxes denote a position on which data has to be filled in. In this case the Destination Airport's ICAO Code is required.
- Stripes that are placed below a line title denote a position at which data may be filled in, but isn't particularly necessary.
- Pink letters commonly denote the next active waypoint or routes to these points.

Prompts
The next part of the display contains one or more prompts. Prompts can have various functions, the most common one being a reference to a following page. It can also be to activate entered information (pressing the EXEC-Button may be necessary afterwards). Prompts can be recognized by the little arrow to their right or left, depending on which side of the display they are. The arrow denotes a reference to a line select key that should be pressed to select the prompt.

Scratchpad
The last and bottom-most part of the display is the scratchpad. Here's where anything you type will appear. Use the line select keys to transfer the data into a line in the Central Information Area.

CDU Pages / Sections

There are seven truly distinct sections in the CDU, and two sections that provide a single function and only one page to fulfill that function. As such, you might call these just "page", and not "section", since the latter implies that several pages are devoted to that function. For clarity and coherence, *all* will be dealt with as "sections", and no internal distinctions will be made.

IDENT page

The IDENT page, or identification page, contains very basic, general information and data on the aircraft you find yourself in. It notes the aircraft type, engine type, nav data cycle and if it's still active or out of date. You don't have to do a lot here except check if all the information is correct or current.

Two prompts are displayed. The prompt INDEX will get you to the index page that lists the most common entries in the correct order for FMS setup. The second prompt, POS INIT, will get you to the second step of the FMS initialization, namely the entering of your current position. Note that the IDENT page can't be accessed by a physical button. To access it, you have to go to the index menu, and then select the IDENT page form there. Now follows a description of the items on this page:

AIRCRAFT   Lists the aircraft model

NAV DATA   Lists the Navigation Database's version and the expiration date

HW CONFIG   The aircraft's hardware (HW) configuration

SW CONFIG   The aircraft's software (SW) configuration. This also shows the product version.

ENGINES   Lists the engine type on the aircraft model

SUPP DATA   Lists any supplementary data

INDEX page

```
      INIT/REF   INDEX

 < IDENT                NAV DATA >

 < POS              FLIGHT PLANS >

 < PERF             LOAD ATC RTE >

                        LOAD PNL >

 < APPROACH             SAVE PNL >

 < LOAD FUEL            SAVE FPL >
```

The INDEX section is slightly strange, because it can't be directly accessed with any one of the CDU's keys. It functions much like the page of contents of a book, offering entries to the other CDU pages. As such, you will find only prompts on the INDEX page, and no data entry lines. However, the Qualitywings Ultimate 146 Collection's INDEX page is much more than just a page of contents. It contains various options that are purely for the benefit of the user and do not exist in the real plane, mostly for obvious reason.

The prompts on the INDEX page are as follows:

IDENT   link to the identification page, which contains information on the airplane, including its engine type and navigation database version

POS   link to the position section

PERF   link to the performance and reference section

APPROACH   link to the approach page

LOAD FUEL   manually load the fuel quantity set by the QualityWings Dispatcher

NAV DATA   Gives access to backups of navigation databases if the active database were to expire. This isn't an active, working feature of the Qualitywings Ultimate 146 Collection.

FLIGHT PLANS   Does two things. First of all it provides a list of all default MSFS flight plans available to you, and secondly a option "NEW FPL" at the very end of the list enables you to create a new flight plan using the default MSFS flight planner.

LOAD ATC RTE   Directly loads the currently loaded MSFS flight plan. This is a flight plan you loaded via the default MSFS flight planner.

LOAD PNL   Shows you a list with available panel states that this plane can load. Enables you to load a panel situation on the fly. This is useful to quickly load a cold and dark situation, or continue a previous flight by loading the relevant in-flight panel situation.

SAVE PNL   Save the current panel situation

SAVE FPL   Save the current flight plan

POS page


```
          POS   INIT        1 / 1
                        LAST  POS
            N48° 05.1   E016° 35.2
  REF   AIRPORT
  LOWW
  GATE
  -----


  UTC                  MON DY/YR
  0921.2Z              APR  05/12
  --------------------------------
  ‹INDEX                    ROUTE›
```

The POS INIT, or position initialization page, is the first initialization page to be filled in and it is where you tell the FMS what the aircraft's current position is. This page has been simplified for you and you don't have to enter any coordinates.

We find the following items on this page:

REF AIRPORT	The reference airport. In other words, the airport where you currently are. In this product, this is done automatically for you.
GATE	Set the departure gate here
UTC	Current time in UTC
LAST POS	The last position the airplane was at. This last position is the position the FMS remembered when it was shutdown the last time.
MON DY/YR	Stands for Month Day/Year, and is simply the current date.

After position initialization, performance initialization takes place via the PERF INIT pages. Here is where you enter aircraft weights and basic flight data, such as cruise altitude. Check out the next page.

PERF INIT page
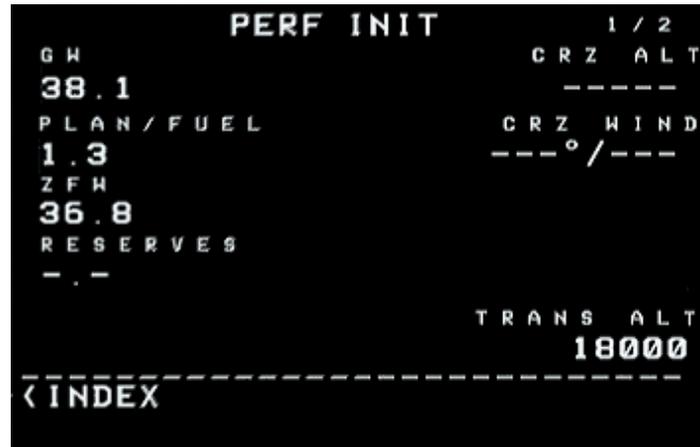
The performance initialization can be accessed by pressing the INIT REF key. Generally, this section provides pages that allow you to enter base data for the various performance calculations that the FMS will perform pre-flight and during the flight.

GW	Gross weight. This is the total weight of your aircraft.
PLAN/FUEL	This is the weight of the fuel planned for the trip.
ZFW	Zero Fuel Weight. This is the gross weight minus the fuel weight. As such, it's the aircraft's weight if no fuel were to be loaded.
RESERVES	This is a value that is optional and is decided on by the pilot depending on various factors. It is the amount of fuel on board (FOB) that is there as a reserve if unexpected problems occur that would lengthen flight time. The amount you enter as reserves depends on your flight plan. If you are always in the vicinity of airports that you can divert to, you won't have to have a lot of reserves. If you do a transatlantic flight, you might need to take bigger reserves with you.
CRZ ALT	Cruise altitude
CRZ WIND	The direction and strength of the wind at your cruise altitude. This is an optional entry.
ISA DEV	The deviation from the International Standard Atmosphere (ISA), which is an internal model that describes how the temperature changes as altitude increases or decreases. ISA DEV gives the temperature deviation in Fahrenheit and degrees Celsius.
T/C OAT	The outside air temperature on takeoff. This figure is important because it's needed for the N1 for the engines on takeoff. See also page 161, on the thrust rating panel (TRP).
TRANS ALT	The selected transition altitude. This is the altitude where you change from your departure airport's barometric pressure to the standard atmospheric pressure (1013hPa).

RTE page

The route section can be accessed by pressing the RTE key. It allows you to enter the route that you will fly.
You do this by entering departure and destination ICAO codes, and subsequently entering the route using the VIA and TO lines.
The amount of pages that the RTE section comprises depends on the length of the route. The longer the route, the more pages are necessary to hold all the information.
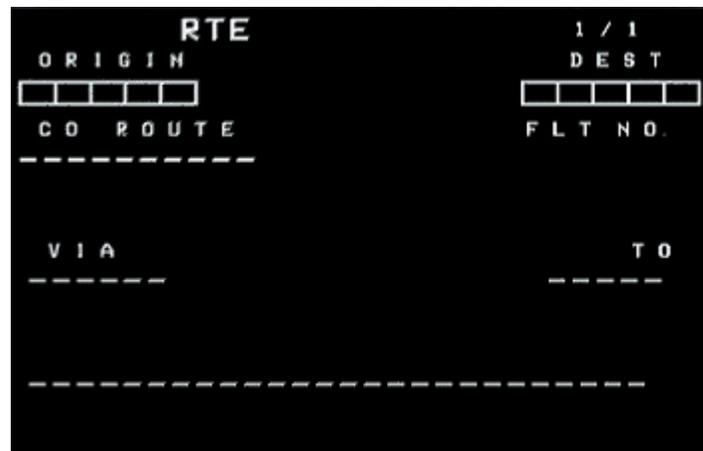
Without a route loaded or entered, the route page will look as in the figure above.

ORIGIN   type the departure airport's ICAO code here.

DEST   type the destination airport ICAO code here.

CO ROUTE   Stands for company route. In case the route you want to fly is stored in the aircraft's database (because it's a standard route the airline company operates), you can type the route name (for example LOWILOWW) in the scratch pad, then press LSK L2 to enter the name on the CO ROUTE line. This will automatically load the route titles

LOWILOWW, if it's indeed stored in the aircraft's database.

FLT NO   The flight number can be entered here.

VIA   In case you enter the route manually, enter airways here that lead to the waypoints that are entered under TO. More info on how to do this will be provided later.

TO   In case you enter the route manually, enter waypoints and such here. If you want to fly according to a specific airway, first enter the airway in VIA, then enter the waypoint in TO, in the same line as the previously entered airway. Note that you do not have to enter airways. You can fly directly from waypoint to waypoint also. In that case, enter the waypoint in TO without entering an airway first.

The display changes once a route is loaded. ORIGIN and DEST will be filled in, and under VIA and TO, you will find the route segments are loaded. See Figure 152. An additional line will now also be available for input: RUNWAY. Here you can enter the departure runway directly by using the alphanumeric keys, or you can select a departure runway by using the departure/arrivals section (explained later).

If a route is too long to be held on just page 1, additional pages are created the hold the rest of the route segments. The format is the same as on page 1 VIA/TO, as it's in principle just a continuation of the data displayed on page 1. Note the stripes in the VIA and TO columns below the last segment. These enable you to add new segments at any time manually by typing them into the scratchpad and pressing the associated line select keys.
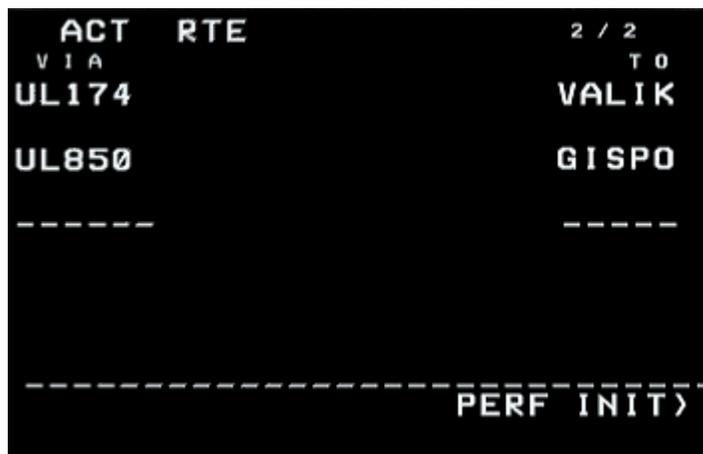
LEGS page

The legs section displays all the separate legs of the route that the plane will fly. It can be accessed by pressing the LEGS key.

Note that while its function sounds similar to the route section, it is a very different thing with an altogether different purpose. Recall that the route section provides a means to enter the route that the plane will fly.

The legs section is designed to show information on each of the legs of which the route-to-fly consists, but it is impossible to create a route from the legs page from scratch. You can however modify the route.

The figure below shows the legs pages after loading a route from LOWI to LOWW (Innsbruck to Vienna). There's a host of information displayed now for each of segments of the route. Note that in the header ACT RTE denotes that the currently displayed route is the active route. The middle section of the display is divided in four columns when viewing the legs page. From left to right, these four columns show various things:

Column 1, small letters	shows the heading you need to fly to reach the waypoint from the position of the previous waypoint.
Column 1, big letters	shows the waypoint's name.
Column 2, small letters	Shows the distance to this waypoint.
Column 3, big letters	Shows the speed at which to fly at this waypoint as was calculated by the FMS based on the data entered into the VNAV section (to be explained later) and possible restrictions
Column 4: big letters	Shows the altitude at which to fly at this waypoint, as was calculated by the FMS based on the data entered into the PERF INIT and various reference pages. If the altitudes or speeds are written in bold, then we're talking about a restriction. If it's not bold, it's a prediction.

These four columns may continue on subsequent pages if the route is too long to be held on a single page only.

Below these four columns you'll find the RNP/ACTUAL entry. RNP stands for *Required Navigational Precision* and is a measure for the accuracy of the FMS that is required in order to fly the route successfully. ACTUAL gives not the required precision, but the precision that the FMS currently sports. If ACTUAL is lower than RNP, than there is no problem. If it is vice versa, than you are not allowed to fly the route due to safety reasons.

The active route, which appears on the LEGS pages, can be modified at any time. As such you can add waypoints, delete waypoint, change altitude and speed targets at waypoint, and close route discontinuities:

Adding waypoints   You do this by typing the waypoint code into the scratch pad. Then insert the waypoint into the LEGS page by using the left LSK of the line on which you want to insert the new waypoint.

Deleting waypoints   You do this by hitting the DEL button (DELETE will appear on the scratchpad) and then selecting the left LSK of the line on which the waypoint to be deleted is positioned.

Changing speed and/or altitude targets

You do this by first typing in the new speed and/or altitude into the scratch pad. There are a few possible ways to do this:

– To change speed only use this layout: xxx/, where "xxx" is a speed in knots, for example 250 knots.

– To change altitude only, type either yyyyy or /yyyyy, where "yyyyy" is an altitude in feet. You can also omit the slash, or just type in type in a flight level. In that case, type a number in the format of "yyy". In summary, typing /25000, 25000 or 250 will all result in an altitude of FL250, or 25000 feet.

– To change both altitude and speed, type your entry in the format xxx/yyyyyy.

Next, press the **right** LSK of the line on which the waypoint is positioned of which you want to change the altitude and/or speed. You don't need to change both speed and altitude if you don't want to. You can change only one at a time. You can even manually enter *the same* values as were written before (so, enter 250/10000, even though this is what was already written).

Whenever you change the active route by adding or deleting waypoint (via the LEGS pages, HOLD page, DEP/ARR page, etc.), a **route discontinuity** will appear.

A route discontinuity is a gap in the active route that needs to be closed. You do this by selecting the waypoint *immediately after* the route discontinuity, and selecting the route discontinuity. This will copy/paste the waypoint onto the discontinuity. As such, the discontinuity is closed.

DEP/ARR page (Departures and Arrivals)

The departures and arrivals section holds pages that display the departure and arrival procedures for the departure and destination airports. The section can be accessed by pressing the DEP ARR key.

Upon pressing the DEP ARR key, an index page will be displayed first. From this page you will be able to go to additional pages to hold all the information on the departure and arrival procedures at the departure and destination airports.

Press the left LSK1 to get to the Departure page. This page now lists all so called Standard Instrument Departures (SIDS) on the left side. SIDS are fixed flight procedures that get published for every airport. On the right side you can select your departure runway. Selecting a runway acts as some kind of filter, that only shows you the available SIDS for that specific runway.

Once selected, the waypoints of the SID are automatically added to your route.

Going to the arrival page, shows a similar layout. On the left you see the so called Standard Terminal Arrival Routes (STARS). Just like with the SIDS, these are standardized flight procedures for your approach.

```
       LOWW ARRIVALS        1 / 4
     STARS           APPROACHES
GAML5W                       VORD16

GBG5W                         ILS16

GIGO1W                       RNAV16

GRZ6W                        VORD34

LANU5W                        ILS34
----------------------------------
<INDEX                       ROUTE>
```

Once we selected a STAR (GAML5W in this case) and an approach, the screen shows us the available transitions. These points are where we transition from our standard arrival route to the actual approach route. We recommend to check the airport charts to see how exactly the routes look like. Major airport's charts are usually published online and can be downloaded for free.

```
       LOWW ARRIVALS        1 / 1
     STARS           APPROACHES
GAML5W   <SEL>  <SEL>   ILSX11
                          TRANS
                         BALAD

                         MABOD

                         NERDU

                         PESAT
----------------------------------
<ERASE                       ROUTE>
```

Once everything is selected, hit the EXEC key to activate your selection. The waypoints are now added to your route. Make sure to check your route for discontinuities. Ideally also go through it in the Plan Format on the Navigation Display.

VNAV page

VNAV stands for vertical navigation and calculates the vertical profile during climb, cruise and descent. It can be accessed by pressing the VNAV key. This is also where you set up the speeds for your flight phases. The results of the VNAV calculations can be seen on the LEGS page in form of the target speeds and altitudes at each waypoint.

In total there are three VNAV pages. One for each flight phase.
Below you will find each of the VNAV pages, with a list of the items to be found on the respective page.
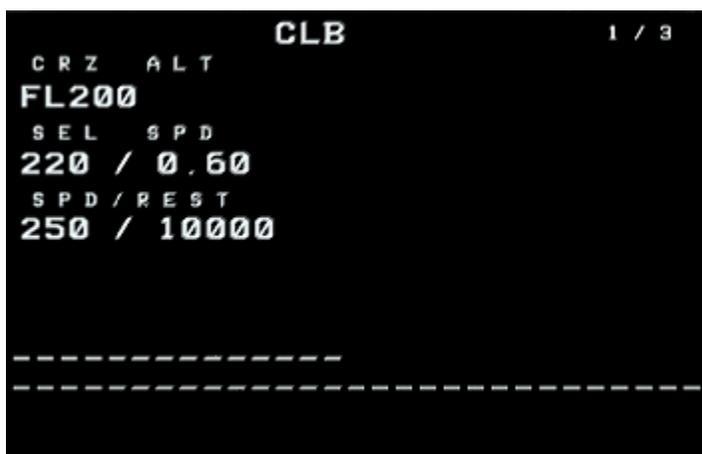
The VNAV Climb page contains the following items:

CRZ ALT   Your flight's cruise altitude

SEL SPD   Gives the selected climb speed in both knots and mach. Change it by typing your desired speed into the scratchpad and pressing the appropriate LSK.

SPD/REST   Gives the speed restriction and altitude of it. In this case 250kts below 10000 ft.
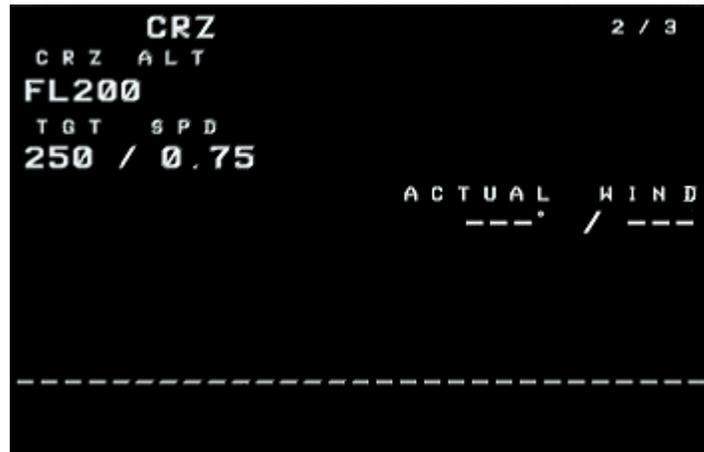
The VNAV Cruise page contains the following items:

CRZ ALT   Your flight's cruise altitude

TGT SPD   Gives the target cruise speed in both knots and mach. Change it by typing your
                         desired speed into the scratchpad and pressing the appropriate LSK.

ACTUAL WIND   The heading and speed of the current winds.
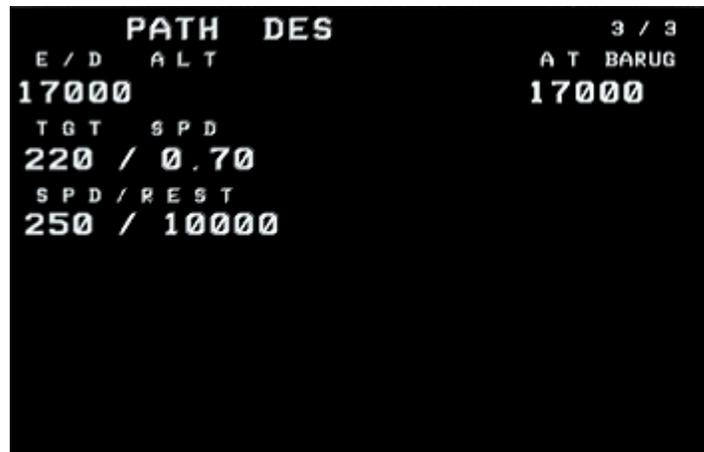
The VNAV Descent page contains the following items:

E/D ALT   The altitude at the end of the descent. In this case there is an altitude
                         restriction of 17000ft at BARUG

TGT SPD   Gives the target cruise speed in both knots and mach. Change it by typing your
                         desired speed into the scratchpad and pressing the appropriate LSK.

SPD/REST   Gives the speed restriction and altitude of it.

AT XXXXX   The altitude at your next waypoint with a restriction. This can also show your
                         destination airport's ICAO code.

HOLD page

The HOLD pages enable you to quickly insert a holding point into your route. Holding points are simple racetrack-shaped circuits that aim to keep the plane around a certain waypoint.
A plane is generally put into hold like you would put a phone call into hold: because there either is a more important phone call while you are already calling, or because you were already calling while you got another phone call. The second phone call will have to wait while you finish the first phone call.

It's the same in the air: if a plane is already landing and there is no slot for your plane available immediately, your plane will be put on hold by ATC. They will tell you where to execute the hold, and via this FMS page, you will be able to set that hold point and comply with ATC instructions.

The HOLD page is a combination of the LEGS page with a new command, found at the very bottom of the page, just above the scratchpad. When a route is loaded, the route will appear on this page in full, in the same format as on the actual LEGS page.

To insert a hold point, enter its code into the boxes under HOLD AT. Alternatively, press the LSK that goes with the route's waypoint at which you wish to hold. Now enter that it into the HOLD AT data boxes. It is however not possible to enter a waypoint that is not part of the entered route.

You can also make a hold point by selecting the PPOS prompt. This will create a holding pattern at your present position (PPOS stands for "Present Position").

Regardless of the method you choose, a hold point will be automatically created at the chosen location (present position or a specific waypoint).
When this happens the HOLD page will immediately change to display all the information related to that hold point, enabling you to change several parameters, or create new hold points. See the next page for an explanation of the various parameters.

```
        MOD   RTE      HOLD      1 / 1
  F I X
  GSB
                                    F I X   E T A
                                      . . / .

  I N B D   C R S / D I R
  057 / R  T U R N
  L E G   T I M E
  1.0    M I N
  L E G   D I S T          B E S T    S P E E D
  --.- - N M                  220  K T
  - - - - - - - - - - - - - - - - - - - - - - - -
  < NEXT HOLD        EXIT HOLD >
```

In the figure above you can see the HOLD page once a hold point has been created. There are various things to see here:

FIX   Gives the name of the fix at which the hold point starts

INBD CRS/DIR   Gives the inbound course and direction of the hold point. This is the course at which you fly once you enter the holding pattern, and the turn that you will make once in the holding pattern. This can be modified.

LEG TIME   Gives the amount of time each leg will take in minutes. This means that you after a full 180-degree turn, you will fly this amount of minutes before turning 180 degrees again and flying back. This can be modified.

LEG DIST   The length of the leg in nautical miles. This can be modified.

FIX ETA   The estimated time of arrival at the holding point fix.

REST SPEED   The speed at which you will fly the holding pattern. This can be modified.

The two prompts at the bottom do the following:

NEXT HOLD   Enables you to create a new hold point. When you press this prompt, you will be taken back to the LEGS/HOLD page (Figure 163 or Figure 165), so you can enter a new point for holding.

EXIT HOLD   Enables you to get out of the holding pattern. This will delete the hold point from the LEGS page.

If you have more than one hold point defined, you will notice that the HOLD page has become a hold *section* holding multiple pages though which you can flip using the PRV and NXT buttons.
On the LEGS page, the hold is added this way:


```
  031°      4734 NM
  GSB
                      250 / FL200
   HOLD   AT
  GSB              - - - - / - - - - -
  053°       55 NM
  LNZ
                      250 / FL200
  087°      32 NM
```

FIX page

The FIX section enables the pilot to look up a navigational point. This navigational point can be any-thing: a waypoint, an airport or navaid. Whatever is entered into the FIX page, will be displayed on the EHSI/ND as well when it is in range.

Any navigational point in the FMS's database can be called up and displayed using the FIX page. Fur-thermore, you can add radials and distances and these will also be shown on the EHSI. The figure below shows the FIX page without any navigational point being entered.
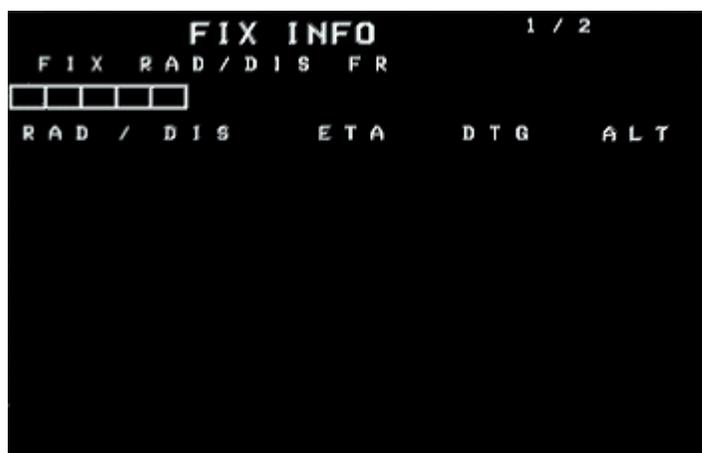
To request a navigational point, enter the navigational point's code into the FIX data boxes (LSK 1L). You will then be presented with the radial and distance to that navigational point (RAD/DIS FR), along with three empty lines. On these lines you can enter a radial (RAD) and distance (DIST), in format xxx/ yyy, where x is a radial in degrees, and y is a distance in nautical miles. See the figure below.

To enter a radial and distance, type both a radial in degrees, followed by a distance in nautical miles. As such you will have created a radial, and the entered distance will appear as a circle around the naviga-tional point, which represents the entered distance from the navigational point.

NAV RAD page

The navigation and radios page is a portal to navigation radios on the plane. From here you can change frequencies of the VOR radios by typing a new frequency into the scratchpad and then using the line select keys to enter the new frequency into the either left or right VOR radio.
This page can be accessed by pressing the NAV RAD key.
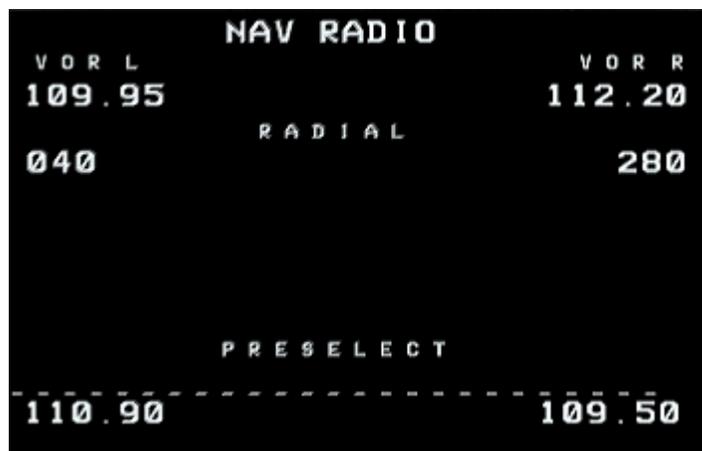
Now follows a short rundown of all the items on the page:

VOR L   Enter frequencies of the left VOR channel here.

VOR R   Enter frequencies of the right VOR channel here.

RADIAL   the selected radials for the respective VOR frequencies.

PROG page

The progress section is designed to give you a comprehensive summary of the flight's progress, giving information on the previous -, the next waypoint and destination including estimated time of arrival and remaining fuel on board. It can be accessed by pressing the PROG key.

The progress pages are your main windows into obtaining information on the aircraft's performance while flying, and should be the first pages to access when looking for specific information. The information is spread out over two pages.

The first of which is mainly tailored to giving route-related information, such as times and distances. The second one lists weather-related information. See below for details.

You can find the following items on the first progress page:

FROM   The waypoint you are coming from.

TO   The waypoint you are flying to.

NEXT   The waypoint you will be flying to next, after the waypoint you are flying to now.

DEST   Your eventual destination.

TO T/D   The estimated time of arrival and distance to the Top Of Descent. This can also be the Top Of Climb.

ALT   The altitude you had at the waypoint you are coming from.

ATA   The Actual Time of Arrival at your last waypoint.

FUEL   The amount of fuel you are coming from.

GW / FUEL   You aircraft's current gross and fuel weight

DTG   The Distance To Go to the listed waypoint.

ETA   The Estimated Time of Arrival at the listed waypoint.

FUEL   The estimated amount of the fuel at the listed waypoint.

Progress page 2:

You can find the following items on the second progress page:

TAILWIND   The speed of the current tailwind in knots

WIND   The angle and speed of the winds.

XTK ERROR   The Cross Track error. This is the displacement of the aircraft from the desired lateral track.

CROSSWIND   The direction and speed of the current crosswind in knots

SAT/ISA DEV   Deviation from Static Air temperature (SAT)/International Standard Atmosphere (ISA). SAT, or Outside Air Temperature (OAT), is the temperature of the air around the aircraft, but without being affected by the passage of the aircraft through it. ISA is an atmospheric model that describes the changing of temperature as you climb to higher altitudes. This line gives the deviation from both the SAT and ISA temperatures.

TAS   The current true airspeed in knots

APPROACH REF page

The approach reference page gives you all the necessary information you need for your approach. It can be accessed via the INDEX page or by pressing the INIT REF key when you're in the air.

```
         APPROACH REF
   GROSS WT    FLAPS        VREF
   38.9         33        121 KT
   VNAV APPR
   ON/OFF
   APPR ENABLE
   ON/OFF
   LOWW 11               WIND CORR
   11484FT 3500M           05   KT
    ILSX 11              FRONT CRS
   110.30                 113°
   ------------------------------
   <INDEX            ALTN DEST>
```

You can find the following items:

GROSS WT   Your aircraft's current gross weight

VNAV APPR   Function not available in this product.

APPR ENABLE   Function not available in this product.

LOWW 11   This is the runway length of your programmed landing runway

                (here: Runway 11 at Vienna airport)

ILSX11   This is the ILS frequency you have to tune to receive the ILS signal

FLAPS   The flaps setting you will use for landing. This can either be 24 or 33

VREF   The reference speed for your landing. This is automatically calculated according to gross weight and flap setting

WIND CORR   Wind Correction. Add this to the calculated reference speed

FRONT CRS   This is the course / radial of the ILS localizer at your arrival runway

HOW TO OPERATE THE GNLU910

This is a short summary and workflow on how to program your FMS for a flight.

Entering a route

You enter a route by going into the route page (RTE button).
Decide whether you want to load a route from the FMS database, or create a new one.
If you want to load a route from the database, enter the route's name and press LSK 2L (CO ROUTE line). This will automatically load the route into the FMS.
If you want to build the route yourself, continue reading.

Enter ORIGIN and DEST ICAO codes.

Under VIA, enter an airway if an airway connects you to the next waypoint.

Under TO, on the same line as where you entered an airway under VIA, enter a waypoint.

You can enter a waypoint under TO without entering a waypoint under VIA. In that case, the FMS will assume you will be going directly to the entered waypoint and will display DIRECT under VIA.

Continue doing this until the entire flight plan is entered into the FMS.

When ready select the ACTIVATE prompt. The light above the EXEC key will illuminate.

Press the EXEC key to execute the changes.

Modifying a route

Modifying a route is done in the LEGS page. You can add waypoint, delete them, or modify altitude or speed targets.

Adding waypoints: You do this by typing the waypoint code into the scratch pad. Then insert the waypoint into the LEGS page by using the left LSK of the line on which you want to insert the new waypoint.

Deleting waypoints: You do this by hitting the DEL button (DELETE will appear on the scratchpad) and then selecting the left LSK of the line on which the waypoint to be deleted is positioned.

Changing speed and/or altitude targets: You do this by first typing in the new speed and/or altitude into the scratch pad. There are a few possible ways to do this:

To change speed only use this layout: xxx/, where "xxx" is a speed in knots, e.g. 250 knots.

To change altitude only, type either yyyyy or /yyyyy, where "yyyyy" is an altitude in feet. You can also omit the slash, or just type in type in a flight level. In that case, type a number in the format of "yyy". In summary, typing /25000, 25000 or 250 will all result in an altitude of FL250, or 25000 feet.

To change both altitude and speed, type your entry in the format xxx/yyyyyy.

Next, press the **right** LSK of the line on which the waypoint is positioned of which you want to change the altitude and/or speed. You don't need to change both speed and altitude if you don't want to. You can change only one at a time. You can even manually enter *the same* values as were written before (so, enter 250/10000, even though this is what was already written).

Closing route discontinuities

Whenever you change the active route by adding or deleting waypoint (via the LEGS pages, HOLD page, DEP/ARR page, etc.), a **route discontinuity** will appear. A route discontinuity is a gap in the active route that needs to be closed.
You do this by selecting the waypoint *immediately after* the route discontinuity, and selecting the route discontinuity. This will copy/paste the waypoint onto the discontinuity. As such, the discontinuity is closed.

Adding a hold point

Adding a hold point is done as follows:

go to the HOLD page.

Enter the ICAO code of the waypoint you want to hold at, or use the left LSK to choose a way point from the active route.

Press LSK 6L to enter the ICAO code into the HOLD AT data boxes. This will insert a hold point of which the starting point will be the waypoint you entered.

After successfully creating the hold point, you will be taken to a new HOLD page, which contains options to modify how the hold point is flown. Modify the hold point if you so desire. Use the prompt NEXT HOLD to create a new one or, if you are already flying the hold pattern, use the EXIT HOLD prompt to exit the holding pattern and continue flying the active route.

HONEYWELL GNS-XLS - BAe146 Series
General CDU layout

The GNS-XLS has a small Control Display Unit (CDU), which can be found on the upper part of the center console, forward even of the throttle quadrant.

The GNS-XLS CDU has a small window spanning about a third of the entire CDU. On the top row of the CDU you can find a row of section keys. Below the display you find a normal keyboard, with a special ENTER and space key (SP). The space key is however only functional when AFIS is fitted, which isn't the case here; it is a customer option which needn't work even on the real aircraft. To the right of the display there is a numerical keyboard and some more section keys. On the left there are four section keys.

Line select keys (LSKs)

On the left and right edges of the display, you can see ten keys, five on each side. These are the *Line Select Keys* (LSK). These enable you to select specific data that's displayed on the display by highlighting them, and confirming or change them by either pressing ENTER or the alphanumerical keys. The line select keys (LSKs) are numbered. The keys to the left of the display are numbered L1 – L4, L1 being the top-most, and L4 being the bottom-most. The keys to the right of the display are numbered R1 – R4 in the same way as the left keys are numbered. When you see LSK L2, the line select key that is second from top, on the left side of the display, is meant.

CDU display selector keys and other buttons

The CDU has several display selector keys, which can be found along the top of the CDU and the left and right sides of the CDU. These keys allow access to the different sections of pages of the FMS. Most display selector keys work in the same way. The first press activates the section key's top page, and any subsequent press lets you flip through the various pages.

These display selector keys are the following (Figure 2, red rectangles):
   NAV: Allows access and cycling through the (lateral) navigation section and its pages.
   VNAV: Allows access and cycling through the vertical navigation section and its pages.
   AFIS: Not functional, as AFIS is not installed on the plane simulated.
   FPL: Allows access and cycling through the flightplan section and its pages.
   PLAN: Allows access and cycling through the planning section and its pages.
   HDG: Allows access to the heading section.
   TUNE: Allows access to the radio tuning section.
   DIRECT TO (bow icon): Enables access to a direct-to page.

There are several more special keys not mentioned above. These are the following (Figure 2, blue rectangles)::
   ON: Turns the FMS on. Also turns it off by pressing and holding for three seconds.
   BRT: Inoperative.
   HOLD: Allows access to the holding pattern page and the position fix page.
   BACK: Either deletes an entry or cycles back through the displayed section's pages. Also enables
       display of lists of options associated to cursor position.
   MSG: Allows access and cycling through the message section and its pages.
   PRV: Allows to cycle backwards through a displayed section's pages.
   NXT: Allows to cycles forwards through a displayed section's pages.

CDU page layout, function and color symbology

The CDU's page layout is reminiscent of other CDU page layouts, and as such you won't have a hard time understanding the interface of the GNS-XLS if you have worked with FMS CDUs before. Below, in Figure 3, you see a random page of the GNS-XLS CDU, of the flight plan (FPL) section. It shows the active flight plan. We will use this page in order to describe the layout.

1. The title bar contains basic information about the page.
2. The middle section of the page contains the actual information this page is designed to show. In this case it's the active flight plan.
3. The lower part contains *prompts* with which you can alter or add to the information in the middle selection. The height of the lower part is variable, depending on the amount of options you have to alter the data.
4. In the title bar, the page title is your primary indication as to what page is being displayed.
5. The page number contains two numbers: x/y. X shows the page that is being displayed (page number 1 in Figure 3). Y shows the amount of pages in the section (4 pages in Figure 3).
6. A yellow rectangle denotes the cursor position. The cursor will always encompass the entire field or prompt that it has been placed on. You will be able to then type info onto that field using the alphanumeric keyboard, or press ENTER to select a prompt. There may be a question mark displayed also if highlighting a prompt, but this doesn't have to be the case:
    a. If there's a question mark displayed, you will be guided to a submenu in which you can select additional data. In the example in Figure 3 you will be asked what departure runway, SID and transition point you want to use.
    b. If there is no question mark displayed, highlighting and selecting the option will change the display of info on the currently displayed page.
7. White prompts are not selected, but can be selected using the adjacent line select keys.
8. A little arrow gives some indication as to what line select keys should be pressed to select an entry. Press once to select the upper of the two prompts, pres again to select the lower of the two prompts.

You will have noticed that there is a use of **colors** in the GNS-XLS CDU. The colors stand for a variety of things. Note that not all available uses of the colors, or even all colors, are displayed in Figure 3.

- **Blue is used for:**

    ◊   Waypoints

- **Magenta is used for:**

    ◊   TO waypoints

- **Yellow is used for:**

    ◊   The FROM waypoint
    ◊   Caution and advisory messages
    ◊   Data entered via the CDU but not yet accepted by the computer

- **Cyan is used for:**

    ◊   The date
    ◊   Times
    ◊   Tuned frequencies or codes
    ◊   Altitudes

- **Green is used for:**

    ◊   Navigation data
    ◊   Fuel data
    ◊   General page data

- **White is used for:**

    ◊   Page titles
    ◊   Prompts

- **Red is used for:**

    ◊   Warnings

Turning the GNS-XLS on, initialization it and turning it off

Turning the GNS-XLS on is simple: simple press the ON key at the top center of the display. Upon turning on, the system will initiate a short self test, recognizable by the manufacturer's copyright information displaying and a yellow flashing "SELF TEST" along the top of the screen.

After the GNS-XLS unit has turned on, you will be presented with the initialization page (Figure 5). The current date and time will be shown, and you will be asked to set your current coordinates.
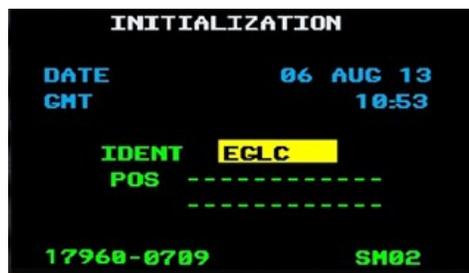
In the QualityWings Ultimate 146 Collection, the GNS-XLS will automatically fill in the ICAO code of the closest airport to your current position. In this case, this is EGLC (London City Airport).

To now enter the exact coordinates, you can do two things:

◊ If the identification code displayed is correct, you can simply press enter and the unit will retrieve the coordinates of EGLC from its navigation database. Press enter again, and the unit will automatically fill in the coordinates in the POS field. Then press enter again to accept this. The unit is then initialized and ready for use.

◊ If the displayed identification code is not correct however, you can simply type another one. The yellow rectangle will denote that the cursor is on that field, so if you start typing, EGLC will be replaced by what you are typing. For example, you may type EGLL, press enter, and it will search the database for the coordinates of EGLL. It will find these and present you with these coordinates. Press enter to accept, and press enter again to finish initialization.

Note that you do not necessarily have to type an airport's identification code! You can type whatever identification code suits your current position best.
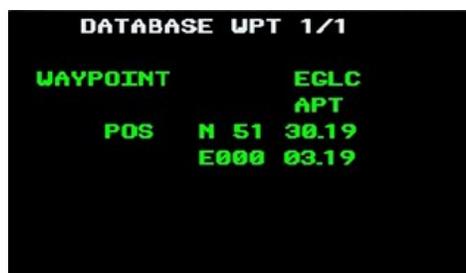
Pressing enter retrieves the coordinates of the pre-filled identifier in the initialization page

Pressing enter again takes the coordinates looked-up in the database and fills them in on the POS field .

When pressing ENTER now, the computer will search the flight plan database to see if there are any stored flight plans originating at the current position. In our case this is the case. There are two flight plans found and displayed on the FLIGHT PLAN LIST PAGE.

If no flight plans are found, you are brought directly to the ACTIVE FLIGHT PLAN page. With this we get into the next section of the FMC: The Flight plan creation and modification pages. We'll continue discussing this in the next chapter.

Flight plan section

You can access the flight plan section by pressing the FPL display selector key, or the FMS may auto-
matically show you one of the flight plan section pages as soon as you are done initializing the system
(see previous chapter).
This section has two main pages in its most basic form. The first one is a page displaying the *active
flight plan*, the second is a *flight plan list*. When there is no active flight plan loaded, this part has only
one page. The flight plan list can show up to 56 flight plans, distributed over 7 pages with up to 8 flight
plans displayed per page. How many pages are shown of course depends on the amount of flight plans
in the [Flight Simulator directory]/Qualitywings/Flightplans folder.

The flight plan section enables you to activate a flight plan, view the active flight plan and modify the
active flight plan by adding or removing waypoints and by adding and removing departure and arrival
runways and procedures. You can also save the flight plan after you created it.

There are currently 2 Flight plan modes, that each successive 'FPL' button press will move though, the
pages and modes.

◊ **First Press - Stored Flight Plans List**

  ◊ If the Flight Plans list has more than one page each successive 'FPL' button press will move to
    the next flight plans list page.

  ◊ The current Flight Plan page mode will be displayed as a label on the top line of the display.

◊ **Second press - Active Flight Plan page**

  ◊ If the active Flight Plan has more than one page each successive 'FPL' press will move to the
    next active flight plan page.

  ◊ The flight plan route currently active (and is displayed in the MCU, MFD or EHSI displays). Any
    changes of updates made in this mode are immediately applied to the current active flight
    plan.

Direct To

On the Direct To page, you can specify 'direct to' a Database waypoint, or 'direct to' a flight plan waypoint.
Press the left LSK's next to the Flight plan item to go direct to. The selected item will highlight in yellow. If the item is displayed as '******' it will be a new flight plan item to the end of the current flight plan list.

When an item is highlighted, characters can be entered by pressing the alphanumeric buttons. After entering the identifier of the new item, press the 'Enter' key. If you select an item and press the 'Enter' button without entering any characters, the selected flight plan wpt will be the 'direct to' item.

This item will also now be the current active flight plan waypoint. If the 'Enter' button is pressed after characters have been entered the 'database wpt' page is displayed to show the details for the new item. After Review/Verify the information on the database page, press the 'Enter' key to go direct to the selected waypoint.

Pressing the 'D->' button until the last page is reached will display a list of the 9 nearest airports, and their bearing and distance from the aircraft's present position.

Database Waypoint

The database wpt page is displayed only when a new flight plan or direct to waypoint is entered to verify the entered identifier is indeed the navaid you wish to be inserted into the flight plan. By default the closest navaid with the same identifier to the aircraft's current position will be displayed.

If there is more than one navaid with the selected identifier, use the PRV/NXT buttons to scroll through the Navaids list.

Notes:
When in LNAV mode the MCU on the 'TO:' page will display the label 'DCTTO 999D' (99D referring to the remaining angle) in degrees. When the remaining angle is less than 180°, the DCTTO label goes off, and the direct heading to the target wpt is entered in the A/P.

Pilot Entered Waypoint

The 'pilot entered wpt' page is displayed only when a selected new flight plan waypoint is not found in the database.
Using the R3 LSK to initial the entry enter the latitude and longitude values of the new waypoint, then press the 'Enter' button to insert the waypoint into the flight plan.

HOW TO Enter A New Pilot Entered Waypoint

1) On the 'Active fpl' page, use the LSK to select/highlight a waypoint.

2) Enter the identifier for the new waypoint that 'does not' match a navaid id already in the database.

3) Press the 'ENTER' button.

4) When no match is found the 'Pilot Entered Wpt' page will display.

5) By default the lat/lon area will be highlighted in yellow for entry.

6) To begin entry first enter a 'N,S,E, or W' character. It will not accept numeric entry until the 'N,S,E, or W' is first entered.

7) If N or S is entered, the top (or latitude) line will accept input.
If 'E or W' is entered, the bottom (or longitude) line will accept input.
A pink cursor will display to show which line is active for entry.

8) Enter the remaining numeric values and press the 'Enter' button.

9) When both the lat and lon values are entered, and the enter button is pressed the new waypoint will be inserted into the flight plan.

Offset Waypoint

An offset waypoint, is a flight plan waypoint who's latitude/longitude position is created relative to the Point, Bearing, and Distance from another navaid.
To enter an offset waypoint, you first select the anchor waypoint and press enter.
The offset waypoint page will display. Using the R3 LSK radial and distance from the selected navaid can be entered.
A step-by-step description on how to add an offset waypoint can be found on the next page.

HOW TO Insert An Offset Waypoint Into The Flight Plan

1) On the active fpl page , use one of the left LSK's to select/highlight a waypoint.

2) Enter the identifier for the anchor waypoint followed by an asterisk '*' (ex MCN*).

3) Press the 'ENTER' button.

4) The 'OFFSET WPT' page will display.

5) Use the right LSK (R3) to select/highlight the RAD and DIS items.

6) The Radial will highlight first, Use the numeric keys to enter the radial value from the anchor waypoint then press the 'ENTER' button to insert the radial value.

7) Press the R3 LSK to highlight the DIS, then use the numeric keys to enter the distance value. Press the 'ENTER' button to insert the distance value.

When there is both a RAD and DIS value, the new lat/lon value will be displayed at the bottom next to the 'POS' label (If you change or update any of the values this will re-calculate).
The bottom of the page will then have a label 'OK? Enter', pressing enter when this is label is displayed will insert the offset waypoint as a new waypoint in the flight plan, with the anchor id followed by an asterisk '*' as the new flight plan waypoint.

Holding Pattern

The hold feature is activated by selecting a waypoint on the Active FPL page, when the waypoint is highlighted (via the left LSK's) press the HOLD button and the HOLD page will display.
By default the inbound course and leg time are set. The inbound course by default is the flight plan track for that waypoint.

Using the right LSK's you can change the leg time or leg distance. Changing the leg time will automatically calculate the leg distance and display it in parens '()'.
Changing the leg distance (LEG DIST) will automatically calculate the leg time and display it in parens '()'. When the aircraft is within 2 miles of the entry point the hold will commence.

The exit mode by default is 'Manual' meaning it will remain in the hold indefinitely until the exit mode is changed.

The exit mode 'AUTO' means the aircraft will leave the hold after completing the current pattern.

The mode can be changed by pressing LSK R5 and pressing the BACK button. Confirm the change with the ENTER key.

Notes:

◊   The Entry type is 'Direct' always and cannot be set in this release.

◊   The hold direction can be changed from Left to Right, the default direction is 'Right

◊   When hold mode is active/on a green hold oval is drawn on the MFD/EHSI at the hold position. A green dot shows the hold leg/position the autopilot is tracking.

VNAV

The VNAV pages allow setting of VNAV options, and viewing of the VNAV status. The VNAV mode has two pages, the first page displays the Vnav status information, while the second page shows the flight plan waypoints and any crossing altitude restrictions.

VNAV Page 1:

VNAV Modes:

◊ **Climb:**   Indicates climb mode, displays as such until the defined cruise altitude has been reached.

◊ **Cruise:**   Indicates at cruise altitude en route to top of descent position.

◊ **Descent:**   Indicates descent to next crossing position.

◊ **Invalid:**   Indicates VNAV will not activate due to VNAV conditions are not currently met.

VNAV Requirements:

1) Cruise Altitude defined (see Vnav data page)

2) At least 1 flight plan waypoint currently loaded in FMS.

VNAV Targets:

◊ **WPT:**   Vnav target is specified flight plan crossing waypoint.

◊ **#TOC:**   Vnav target is top of climb position

◊ **#TOD**   Vnav target is top of descent position

◊ **@#TOD FM DN:**   Vnav target is top of descent position. The initial rate of descent upon reaching the TOD position is displayed.

◊ **RANGE:**   The distance to the Vnav target.

Vnav Page 1 (continued)

◊   **EST CROSSING:**   The estimated crossing altitude based on the aircraft's current descent rate and speed.

◊   **ETE:**   Estimated time enroute to the Vnav target in hours:mins.

◊   **REQUIRED FPM:**   The required vertical speed to meet the Vnav target crossing altitude from the aircraft's present position.

◊   **ACTUAL FPM:**   Aircraft's current vertical speed in per min. The 'DN parameter indicates descent, and the UP parameter indicates climb.

◊   **VERT DEV:**   The altitude deviation above or below the calculated flight path, in feet. The HIGH parameter indicates aircraft is above the flight path the LOW parameter indicates below the flight path.

◊   **CLIMB GRAD:**   Climb gradient, the rate of climb in feet per nm.

◊   **DATA:**   Open the VNAV data page. Press the LSK 5L, it will highlight in yellow. Then press the 'Enter' button to display the VNAV data page.

VNAV Page 2

The Vnav page 2 displays the remaining flight plan waypoints, and any crossing restrictions set.
The 'PRV' / 'NXT' buttons can be used to scroll up and down though the flight plan waypoints.
The first line of the page displays the VNAV mode (Climb,Cruise,Descent,Invalid).

VNAV Data Page

CRUISE ALT: Cruise altitude used by the FMS for TOC/TOD calculations. The value is pre-set when a flight plan is loaded into the FMS. This can be edited by pressing the LSK next to the cruise alt value (left side). The cruise alt will highlight in yellow. Then use the numeric keys to enter a new cruise altitude.
Press the Enter' button to enter the new cruise alt into the FMS.

TRANS LEVEL: Transition altitude. Can be edited, but in this version the transition altitude has no purpose.

DEFAULT FPA: Default flight path angle in degrees (3.0 deg default). The TOC/TOD values are calculated from this FPA value. It can be edited by using the LSK to highlight it. The max value for this FPA is 6.0 deg.

PRESEL ALT: The preset cruise altitude set when the flight plan was first loaded into the FMS.

RANGE The distance to the Vnav target.

ETE: Estimated time enroute to the Vnav target in hours:mins.

Note:

The VNAV on the BAe146 –series is not coupled to the autopilot. Although there is a button for it on the MCP, it serves no function and the pilot has to manually fly the descent to match the GNS-XLS prediction. This is the real-life operation and no simplification from QualityWings.

Navigation Page (NAV)

Navigation page 1

FR: The previous flight plan waypoint. If there is no previous waypoint, this will display as 'Direct'
TO: The current target flight plan waypoint.
DIS: Distance to the target flight plan waypoint.
ETE: Estimated time enroute to the target flight plan waypoint, in hours:min.
DTK: The direct track from the previous waypoint to the target waypoint.
GS: The current ground speed.
WIND: The current wind speed and direction.

Navigation page 2

FR: The previous flight plan waypoint. If there is no previous waypoint, this will display as 'Direct'
TO: The current target flight plan waypoint.
WIND: The current wind speed and direction.
ETA-DEST: The estimated time enroute to the destination.
FUEL: Fuel needed to the destination.
TKE: Track error in degrees the L parameter indicates left the R parameter indicates right.
XTK: The cross track error in degrees the L parameter indicates left the R parameter indicates right.

Navigation page 3

FR: The previous flight plan waypoint. If there is no previous waypoint, this will display as 'Direct'
TO: The current target flight plan waypoint
WIND: The current wind speed and direction
DRIFT: Drift angle in degrees
VAR: current location's magnetic variation (declination W west, E East)
TAS: current true airspeed
HDG: Current heading
BRG: current bearing to the target waypoint
TK: Flight plan track from the previous flight plan waypoint to the next flight plan waypoint

Navigation page 4

POS: Displays the current latitude/longitude position.

Plan page 1 (Fuel status)

REMAINING:	Total fuel remaining
RESERVE:	reserve fuel (this is set in the flight plan file)
FLOW:	Current fuel flow (in lbs. per hour)
HOURS:	Time of fuel remaining in hours:mins
RANGE:	Distance of fuel remaining in nm
NM/LB:	Current distance per lb of fuel burned

Plan page 2 (Trip plan)

GS:	Current groundspeed
DIS/DTK:	distance and flight plan track to target waypoint
ETE:	Estimated time enroute to target waypoint
FPL:	Total destination distance and time remaining
ETA @ DEST:	Estimated time of arrival at destination

Plan page 3 (Fuel Plan)

GS:	Current groundspeed
FLOW:	Current fuel flow
LEG FUEL:	Total fuel estimated to be burned on current flight plan leg
FPL FUEL:	Total fuel estimated to be burned upon reaching destination

Plan page 4 (Fuel Flow)

Individual engine fuel flow and total fuel flow.

Plan page 5

DATE:	Current (FS) date
GMT:	Current (FS) time
TAKEOFF:	Takeoff time
LAND:	Landing time
FLIGHT TIME:	Total flight up to current point

Plan page 6 (Aircraft Weight)

BASIC OP WT:	Aircraft Empty weight
PAYLOAD:	Total payload weight
FUEL ON BOARD:	Total Fuel on board
FUEL USED:	Fuel consumed during present flight
GROSS WEIGHT:	Current gross weight (in kgs by default)

Plan page 7

Plan page 7 is not present in the real GNS-XLS. It serves the purpose of being able to select a departure runway for airports without an available Standard Instrument Departure (SID). Since the real GNS-XLS in this case does not offer the capability to enter a runway, this page was added to enable the information to be entered for QWPAS announcements.

Plan page 8

Plan page 8 is not present in the real GNS-XLS. It serves the purpose of being able to select an arrival runway for airports without an available Standard Terminal Arrival Route (STAR) or approach. Since the real GNS-XLS in this case does not offer the capability to enter a runway, this page was added to enable the information to be entered for QWPAS announcements.

QualityWings
CONTROL PANEL

The QualityWings Control Panel allows for individual door control as well as selection of several options for the QualityWings Panel.
The Control Panel can be opened via the "QW" Simicon in the 2D Panel or by clicking on the "PEDAL ADJUST" handle in the VC.
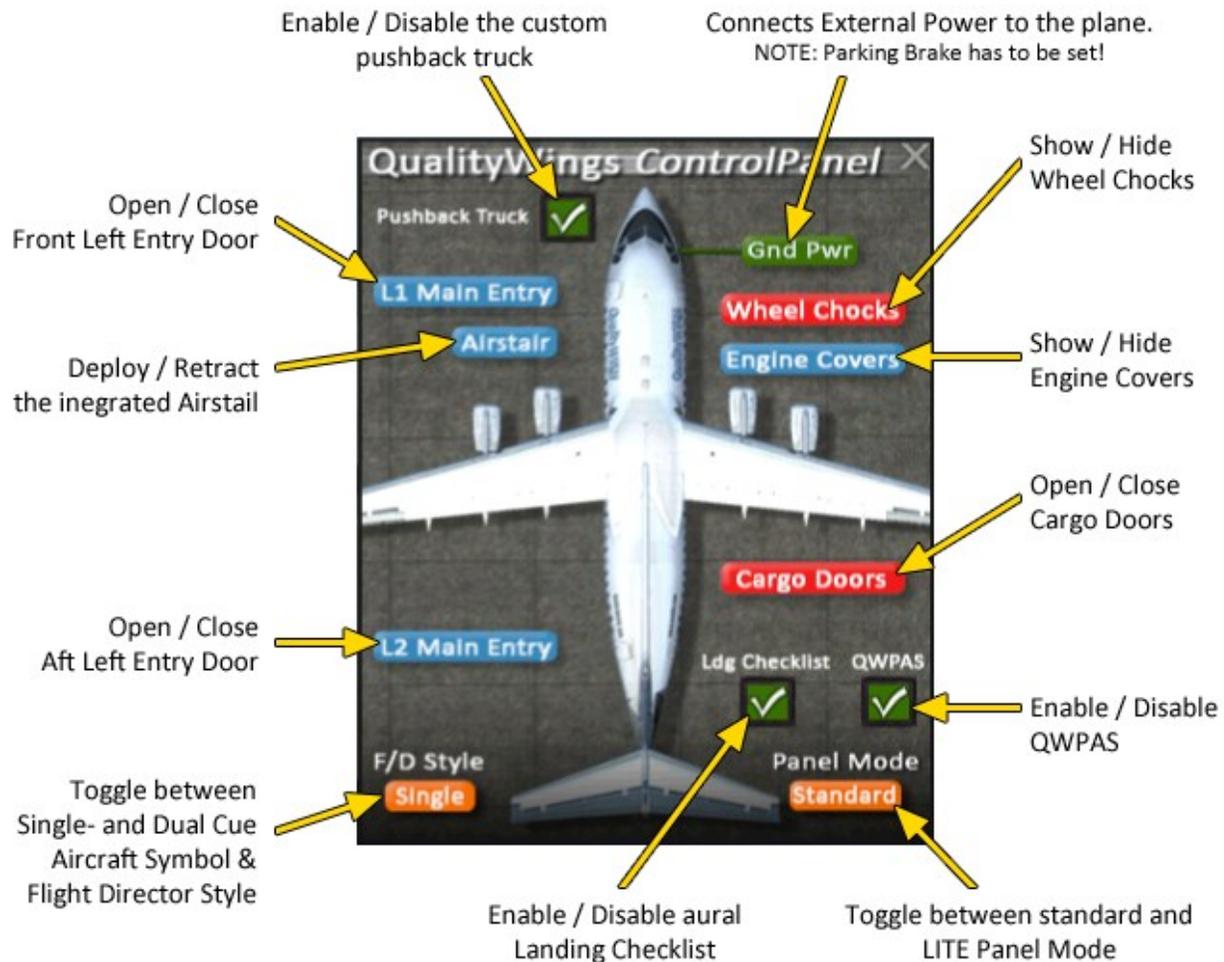
NOTE to FSX Users:

The Airstair is an airline option. Should the Airstair button be greyed out reading "N/A", then the airplane's operator did not choose to fit the Airstair to the plane.

The service doors on the right side of the airplane are only functional in FSX and can be controlled via a button located above the "Cargo Doors" button (not visible in the figure above).

QWPAS

The QWPAS system is a QualityWings exclusive feature that automatically provides cabin announcements for your flight. We promise you will learn to love this QualityWings feature!

The following conditions have to be met in order for the system to work properly:

Mode 1 - Boarding.wav
- L Entry Door open
- Flight Plan active and (EXEC)uted
- Parking Brake Set
- Aircraft On Ground

Mode 2 - Departure.wav
- Mode 1 completed
- All external Doors closed
- Parking Brake set
- Aircraft on ground

Mode 3 - QWSafetyDemo.wav
- Mode 2 Completed
- All External Doors closed
- Aircraft on ground
- Departure Runway selected in the FMS.
- Distance from Departure runway threshold > 3000 ft

Mode 4 - FA Departure.wav
- Mode 3 Completed
- Groundspeed > 5 kts and < 70 kts
- Aircraft on ground
- Distance from departure runway threshold < 1500 ft

Mode 5 - After Takeoff.wav
- Radio Height > 10500 ft or TOC alt reached (whichever is lower)

Mode 6 - After Seatbelts Off.wav
- Mode 5 Completed
- TOC reached

Mode 8 - Immigration.wav
- TOC reached (ie in cruise mode)
- Distance to TOD position < 23 nm
- Departure airport code begins with K,P,'NS','TI', or 'TJ' and destination airport code is not of the listed departure codes (ie US departure to Europe/EU destination)

Mode 9 - CustomsInfo.wav
- TOC reached (ie in cruise mode)
- Distance to TOD position < 23 nm
- Destination begins with K,P,'NS','TI', or 'TJ' and destination airport is not of of the listed departure codes (ie non US departure, US arrival).

Mode 10 - Initial Descent.wav
- TOD reached

Mode 11 - Final Approach.wav
- Mode 10 completed
- Radio Height < 7000 ft
- Flaps >= 5 degrees

Mode 12 - FA Arrival.wav
- Mode 11 completed
- Flaps >= 20 degrees
- Gear Down
- Radio Height < 4000 ft

Mode 13 - After Landing.wav
- Mode 12 Completed
- Aircraft On Ground
- Groundspeed < 35 kts.

Notes:
- None of the subsequent modes will play unless the conditions for mode 1 are met first.
- There are built in delays after each file is played to prevent sound playing overlaps.
- There is no Mode 7 in the Ultimate 146 Collection as we changed the logic for the „Seatbelts ON" announcement. It is now directly tied to the Seat Belt Switch Position.

QWPAS Customization

QWPAS allows for custom Airline Safety Demos (QWPAS Mode 3).
Available custom Safety Demos can be downloaded directly from our website, labeled as "Safety Demo (146)":

http://qwsim.com/index.php/downloads?c=qwpas&m=757

For the Ultimate 146 Collection the Safety Demos come with a simple installer that does the job for you.
Simply download the file and execute it. Make sure you have the according livery installed. The next time you'll do a flight you will hear your favorite airline's real safety demo!

—INTENTIONALLY LEFT BLANK—

SYSTEM MODES

Systems Programming

QualityWings understands that flight simmers come in MANY different flavors. Some users love a hard-core simulating experience and want to be in control of every area of the aircraft they are flying. They take pride in learning systems and operating the aircraft to every detail possible within the limitations of Microsoft Flight Simulator. There are also MANY more users who couldn't care less what's going on with the aircraft. They want to fly from point A to point B as quickly as possible without having to setup an entire cockpit.

We have put A LOT of thought into the design of the Ultimate 146 Collection panel and systems, and through a combination of intuitive programming and a bunch of Customizable User options - we believe we have created an experience that EVERYONE can enjoy.

The real-life Boeing Avro RJ / BAe146 is an incredibly complex aircraft, with hundreds and hundreds of processes going on "behind the scenes"...yet, a certain level of pilot interface is required. We have tried to create an experience that does not overwhelm you, but it is sophisticated enough to keep you on your toes in some cases.

Panel Modes: Standard vs. Lite Mode
Standard panel mode is the most realistic of the 2 panel modes and while it's not extremely complicated, there are users who really like a true Lite experience. Enter QualityWings LITE Mode. At the touch of a button, several 'advanced functions' are disabled. Lite Mode consist of the following:

- VNAV disabled.
- Autoland disabled.
- FLCH disabled.
- Thrust Hold disabled.
- Single button push complete start/shutdown option (Start/Stop button displays on overhead panel).
- Z key toggles on/off A/P.
- CTRL-H toggles on/off heading Sel mode.
- CTRL-Z toggles on/off altitude hold mode.
- Vertical speed window always open.
- When Alt Hold is activated V/S hold is also activated.
- LNAV will engage (not arm) if selected, it will immediately turn to the next active wpt instead of flying the current heading until intercepting track (intercept heading not required).
- Autopilot can be turned on anytime (even on the ground).
- Speed/Mach hold can be activated anytime (even on the ground).
- Pressing CMD button toggles on/off autopilot.
- Heading hold disabled (only Heading select is available).
- Automatic Air switching for proper Air Conditioning.
- IRS will align whether aircraft is in motion or not.
- Warning Chimes disabled
- In Overhead panel a 'Start/Stop' button displays.

BAe146 only:
- IAS mode enables autothrottle

LITE Mode is selected via the QualityWings Control panel. Upon selecting lite mode, the QualityWings Control panel "Panel Mode" button will switch from STANDARD to LITE and the aircraft will be put into a ready for departure situation.

This means the aircraft automatically:
- Turns on Battery
- Starts the APU
- Aligns IRS's
- Turns on Yaw Damp Master Switches
- Turns on Avionics Master Switches
- Turns on Autopilot Master Switches
- Turns on Hydraulic Pumps
- Turns on Fuel Pumps
- Turns on Electric Generators
- Turns on Ice Protection Systems
- Turns on correct Air Supply setting for pressurization
- Autostarts all Engines

—INTENTIONALLY LEFT BLANK—

QualityWings DISPATCHER

The QualityWings Dispatcher

This handy tool allows you to configure your Ultimate 146 Collection to your needs. It lets you install / uninstall airline liveries and configure your Payload as well as Fuel Quantity.
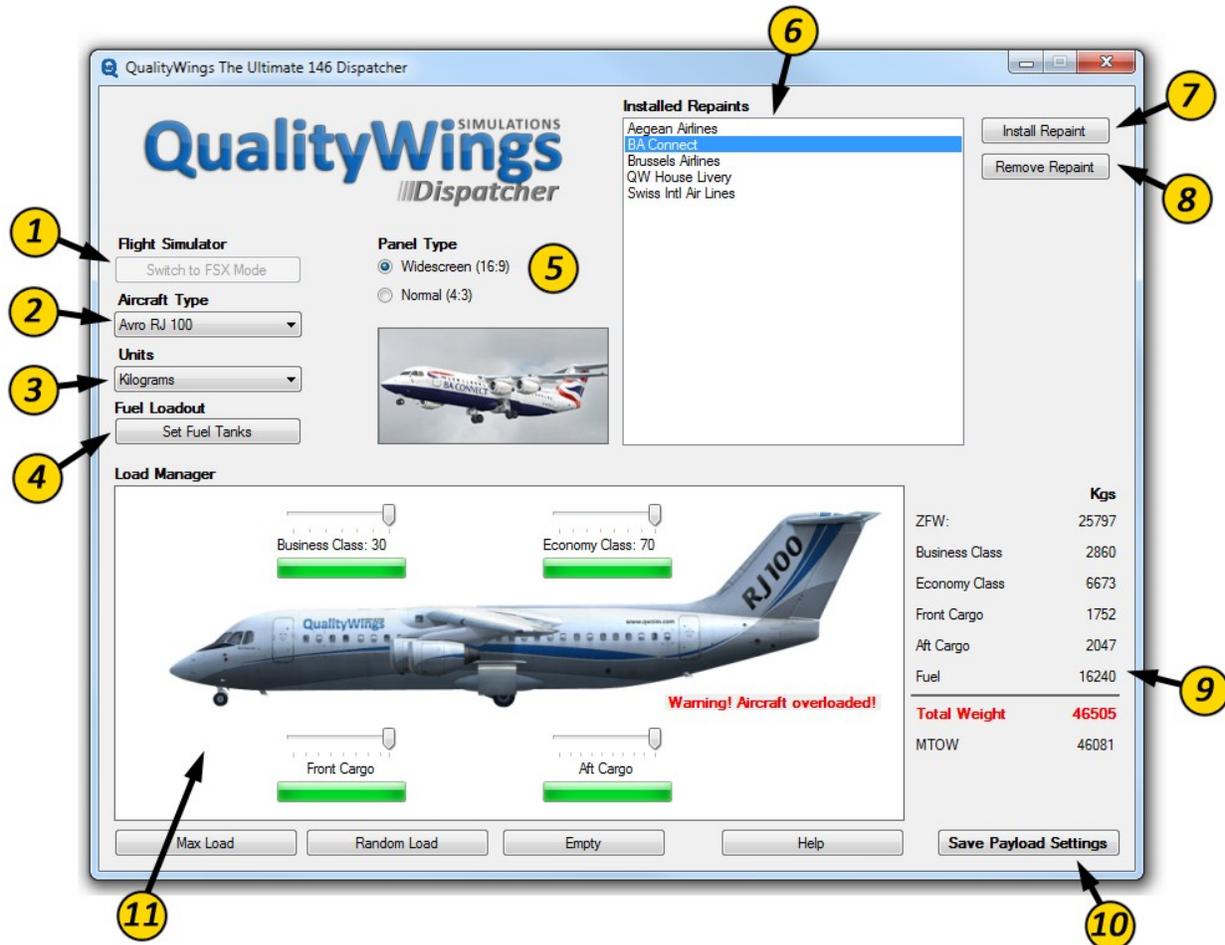
HOW TO INSTALL A REPAINT

Installing a new Repaint for your Ultimate 146 is as easy as that:

a)   go to the download section on www.qwsim.com
b)   Select your desired Livery and save it on your local hard drive
c)   Open the QualityWings Dispatcher from your Start Menu
d)   If you have The Ultimate 146 Collection installed in both, FS9 and FSX, select your desired Flight Simulator using Button (1).
e)   Select your desired Aircraft Type using Button (2)
f)   Click on the Install Repaint Button (7)
g)   Browse to your previously downloaded Livery and click "Open"
h)   You should now see a confirmation that the installation was successful.

Find a detailed explanation of each function on the next page!

Check out the previous page to see the corresponding position of the buttons explained below.

1 – Flight Simulator

> *If you have the Ultimate 146 Collection installed in both, FS9 and FSX, this button lets you toggle between both versions. On the picture, the Dispatcher is currently operating in FS9 Mode.*

2 - Aircraft Type

> *Select the Aircraft Variant you want to load or install Repaints for.*

3 – Units

> *Select either Kilograms or Pounds to be displayed in the Load Manager.*

4 – Fuel Loadout

> *Opens an additional window which lets you set the desired fuel quantity. Check out the next page for more details on this.*

5 – Panel Type

> *The Ultimate 146 Collection comes with both, widescreen and standard aspect ratio 2D-Panels. Choose your desired one here.*

6 – Installed Repaints

> *A list of Repaints installed for the selected Aircraft Type. Select a Repaint to configure.*

7 – Install Repaint

> *Download a Repaint from the Downloads section on qwsim.com and save it on your local hard drive. Press the "Install Repaint" button and browse to the file to install it. You will get a confirmation if the installation was successful.*

8 – Remove Repaint

> *Removes a selected repaint from your installation. The removal of the QualityWings House Livery is not possible.*

9 – Load Manager / Weights

> *Lists all the currently configured payload weights of the airplane.*

10 – Load Manager / Save Payload Settings

> *Always save your settings after having made changes to your payload. Changes will not be effective until being saved.*

11 – Load Manager

> *Allows you to configure your payload stations individually. Simply drag the Sliders to adjust each station's load. You will get a red warning if your aircraft weight exceeds the Maximum Allowed Take Off Weight.*
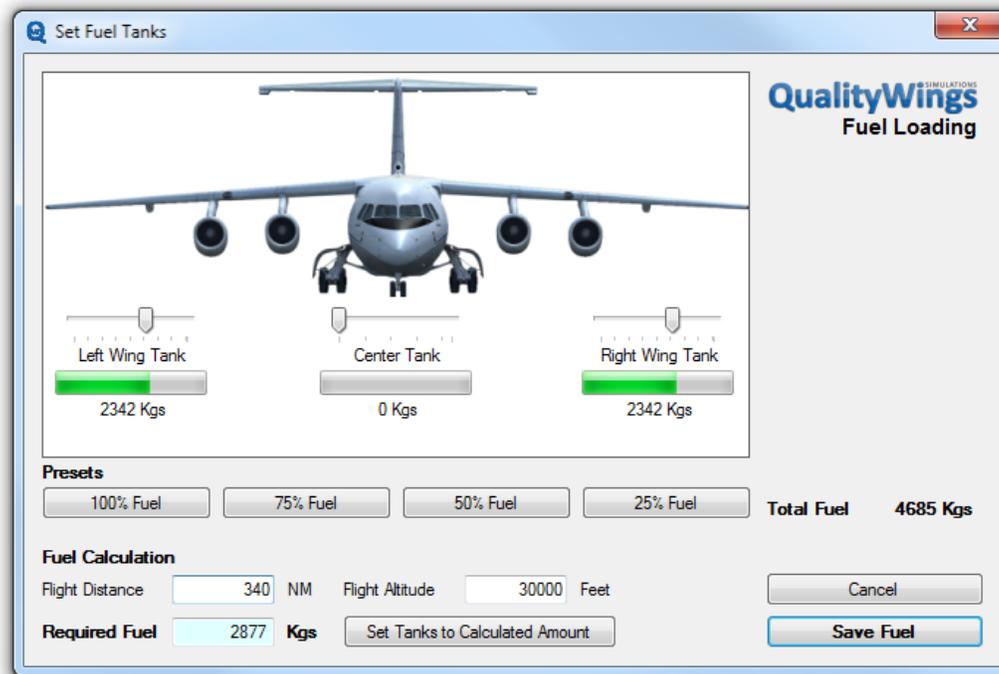
HOW TO USE THE FUEL CALCULATOR
Finding the right amount of fuel for your flights is child's play with our Fuel Calculator!

a) Open the Fuel Manager by clicking the "Set Fuel Tanks" (4) button on the Dispatcher Main Window
b) Insert the distance of your flight in nautical miles in the "Flight Distance" window
c) Fill in your desired cruise altitude in feet
d) Click "Set Tanks to Calculated Amount"

That's it! The next time you load the airplane in Flight Simulator it will have the right amount of fuel for your planned route. Do note that this doesn't include significant reserves. We recommend to add a bit of reserve fuel.

NOTE:
If a formerly saved flight is loaded, no change is being made to the fuel load. You can however manually load the fuel amount by selecting "LOAD FUEL" on the FMS's Index page.

CHECKLISTS

```
                        Avro RJ70/85/100
                  =====  NORMAL CHECKLIST  =====

            =======================================
                      FLIGHT DECK SAFETY
            =======================================
```

ELECTRICS
```
        BATT Switch ................................... ON
        VOLT/AMP selector ......................... BATT
        Voltage ................................. Min 23V
        BUS-TIES .................................... AUTO
        STBY INV ..................................... ARM
        STBY GEN ..................................... ARM
        GENS 1 and 4 ........................... OFF/RESET
        APU GEN ....................................... ON
        APU (if required) ......................... START
        EXT AC (if required) .................... CHKD,ON
```

MASTER SWITCHES
```
        YAW DAMP MASTER 1 and 2 ..................... ON
        FGC SELECT .............................. 1 or 2
```
        Recommend: 1 on odd, 2 on even days
```
        AP MASTER 1 and 2 ............................ ON
        AVIONICS MASTER 1 and 2 ..................... ON

        GRND IGN ................................ AS REQD
```
        Recommend: A on odd, B on even days

ANTI-SKID and LIFT SPLRS
```
        ANTI-SKID switch ............................. ON
        AUTO SPLR .................................... ON
        LIFT SPLRS YEL and GRN ...................... ON
```

AIR CONDITIONING
```
        Pack 1 and 2 switches ...................... OFF
        RAM AIR switch ............................. SHUT
        APU AIR ...................................... ON
        FLT DECK & CABIN TEMP ...................... AUTO
        CABIN FAN ................................ AS REQD
        FLT DECK FAN ............................. AS REQD
```
HYDRAULIC
```
        AC PUMP ...................................... ON
        PTU switch ................................... ON
```
LIGHTS & NOTICES
```
        NAV LIGHTS ............................... AS REQD
```

MAIN PANEL
```
        FLIGHT INSTS ............................... CHKD
        FLIGHT ANNUNS ............................ TESTED
        AUTOPILOT .............................. CHKD,OFF
```

RECEIVING AIRCRAFT

```
========================================
              BEFORE START
========================================

SAFETY CHECK .......................... COMPLETE
BRAKES ...................................... PARK
HYDRAULICS ............................... ALL OFF
FUEL PANEL ....................... CHKD, AS REQD
LIGHTS&NOTICES ............................... SET
AIR CONDITIONING ....................... AS REQD
THRUST LEVERS ....................... FUEL OFF
ALTIMETERS ................................... SET
AC POWER ................................. AS REQD
DOORS & WINDOWS ........................ CLOSED
TRP/N1/SPEEDS .................... CHKD,BUGS SET
TRIMS ....................................... SET

========================================
                STARTING
========================================

BEACON ......................................... ON
PACKS & APU AIR .............................. OFF
ENG ANT-ICE ................................... ON
BRAKE FANS ................................... OFF
AC PUMP ...................................... OFF
FUEL PUMPS .................................... ON
START PANEL .................................. SET
TRANSPONDER ............................ AS RECQ

========================================
              AFTER START
========================================

START PANEL .................................. SET
ENG ANT-ICE .............................. AS REQD
GENERATORS ................................... ON
EXTERNAL AC ................................. OFF
BRAKE FANS .............................. AS REQD
HYDRAULICS ........................... ON & CHKD
HEATERS ....................................... ON
SPEEDS/N1 .................................. CHKD
APU/ENG AIR ............................. AS REQD
PACKS/CABIN AIR ........................ AS REQD
```

AIRCRAFT START UP

```
======================================
             BEFORE TAKEOFF
======================================

BRAKES ...................................... CHKD
FLAPS ........................................ SET
FLT INSTRUMENTS ............................. CHKD
TRIMS ....................................... CHKD
CONFIG ...................................... CHKD
CONT IGN ................................. AS REQD
CONTROLS .................................... CHKD
MWS ......................................... CHKD
A/T ...................................... AS REQD
LANDING LIGHTS ................................ ON


======================================
             AFTER TAKEOFF
======================================

GEAR ............................. UP & LIGHTS OUT
FLAPS ....................................... ZERO
TRP ...................................... AS REQD
ENG AIR ....................................... ON
APU AIR ...................................... OFF
PACKS ......................................... ON
APU .......................................... STOP


======================================
                CLIMB
======================================

ALTIMETERS ................................... STD
PTU .......................................... OFF
PRESSURIZATION ..................... ΔP BUILDING
LIGHTS ....................................... OFF
FASTEN BELTS ............................. AS REQD
```

TAKE OFF

```
========================================
                 DESCENT
========================================

PTU ........................................... ON
PRESSURIZATION ...................... LDG ALT SET
LAND FLAP ............................... AS REQD


========================================
                APPROACH
========================================

ALTIMETERS ................................... SET
FASTEN BELTS .................................. ON
STEEP APPROACH ........................... AS REQD
APU ...................................... AS REQD


========================================
                LANDING
========================================

GEAR .............................. DOWN 3 GREENS
BRAKES ...................................... CHKD
FLAPS ....................................... CHKD
AIRFRAME ANT & DE-ICE ........................ OFF
LANDING LIGHTS ................................ ON


========================================
              AFTER LANDING
========================================

A/T .................................. DISCONNECTED
AIRBRAKES & SPOILERS .......................... IN
FLAPS ............................. ZERO SELECTED
LIGHTS ................................... AS REQD
STEEP APPROACH ............................... OFF
TRANSPONDER .............................. AS REQD
ENG ANT-ICE .............................. AS REQD
CONT IGN ................................. AS REQD
GENERATORS ............................... AS REQD
ENGINES .................................. AS REQD
```

DESCENT & LANDING

```
=====================================
            SHUTDOWN
=====================================
```

```
BRAKES ...................................... PARK
LIGHTS ....................................... OFF
PRESSURISATION ..................... DEPRESSURISED
HYDRAULICS ............................... ALL OFF
GENS 1 & 4 ............................ OFF RESET
THRUST LEVERS ...................... FUEL OFF
FASTEN BELTS ............................... OFF
BRAKE FANS ............................ AS REQD
FUEL PUMPS ............................ AS REQD
ENG ANT-ICE ................................. ON
BEACON ...................................... OFF
TRANSPONDER ........................ STBY, 2000
```

```
=====================================
          LEAVING AIRCRAFT
=====================================
```

```
IRSs ........................................ OFF
MASTER SWITCHES .............................. OFF
BRAKE FANS ................................... OFF
ANTI-SKID & LIFT SPLRS ....................... OFF
FLTDK EMERG LIGHTS ........................... OFF
PACKS ........................................ OFF
APU AIR ...................................... OFF
APU ......................................... STOP
FUEL PUMPS ................................... OFF
GALLEY SWITCH .............................. SHED
LIGHTS ....................................... OFF
BATT ......................................... OFF
```

LEAVING AIRCRAFT

```
                        BAe146-100/-200/-300
                   =====  NORMAL CHECKLIST  =====

          ========================================
                       FLIGHT DECK SAFETY
          ========================================
```

ELECTRICS
```
          BATT Switch .................................. ON
          VOLT/AMP selector .......................... BATT
          Voltage ................................. Min 23V
          BUS-TIES ................................... AUTO
          STBY INV .................................... ARM
          STBY GEN .................................... ARM
          GENS 1 and 4 .......................... OFF/RESET
          APU GEN ...................................... ON
          APU (if required) ......................... START
          EXT AC (if required) .................... CHKD,ON
```

MASTER SWITCHES
```
          YAW DAMP MASTER 1 and 2 ...................... ON
          AP MASTER 1 and 2 ............................ ON
          AVIONICS MASTER 1 and 2 ...................... ON

          GRND IGN ................................ AS REQD
```
Recommend: A on odd, B on even days

ANTI-SKID and LIFT SPLRS
```
          ANTI-SKID switch ............................. ON
          LIFT SPLRS YEL and GRN ....................... ON
```

AIR CONDITIONING
```
          Pack 1 and 2 switches ....................... OFF
          RAM AIR switch ............................. SHUT
          APU AIR ...................................... ON
          FLT DECK & CABIN TEMP ...................... AUTO
          CABIN FAN ............................... AS REQD
          FLT DECK FAN ............................ AS REQD
```
HYDRAULIC
```
          AC PUMP ...................................... ON
          PTU switch ................................... ON
```

LIGHTS & NOTICES
```
          NAV LIGHTS .............................. AS REQD
```

MAIN PANEL
```
          FLIGHT INSTS ............................... CHKD
          FLIGHT ANNUNS ............................ TESTED
          AUTOPILOT ............................. CHKD,OFF
```

RECEIVING AIRCRAFT

```
========================================
                BEFORE START
========================================


SAFETY CHECK ........................... COMPLETE
BRAKES ....................................... PARK
HYDRAULICS ................................ ALL OFF
FUEL PANEL ....................... CHKD, AS REQD
LIGHTS&NOTICES ............................... SET
AIR CONDITIONING ...................... AS REQD
THRUST LEVERS ..................... FUEL OFF
ALTIMETERS ................................... SET
AC POWER ............................... AS REQD
DOORS & WINDOWS ....................... CLOSED
TMS/N1/SPEEDS ................... CHKD,BUGS SET
TRIMS ........................................ SET


========================================
                 STARTING
========================================


BEACON ........................................ ON
PACKS & APU AIR ............................. OFF
ENG ANT-ICE ................................... ON
BRAKE FANS .................................. OFF
AC PUMP ...................................... OFF
FUEL PUMPS .................................... ON
START PANEL .................................. SET
TRANSPONDER ........................... AS RECQ


========================================
               AFTER START
========================================


START PANEL .................................. SET
ENG ANT-ICE .............................. AS REQD
GENERATORS ................................... ON
EXTERNAL AC ................................. OFF
BRAKE FANS ............................. AS REQD
HYDRAULICS ........................... ON & CHKD
HEATERS ...................................... ON
SPEEDS/N1 .................................. CHKD
APU/ENG AIR ............................. AS REQD
PACKS/CABIN AIR ....................... AS REQD
```

AIRCRAFT START UP

```
======================================
              BEFORE TAKEOFF
======================================

BRAKES ...................................... CHKD
FLAPS ........................................ SET
FLT INSTRUMENTS ............................. CHKD
TRIMS ....................................... CHKD
CONFIG ...................................... CHKD
CONT IGN ................................. AS REQD
CONTROLS .................................... CHKD
MWS ......................................... CHKD
LANDING LIGHTS ................................ ON
```

```
======================================
              AFTER TAKEOFF
======================================

GEAR ........................... UP & LIGHTS OUT
FLAPS ....................................... ZERO
TRP ...................................... AS REQD
ENG AIR ....................................... ON
APU AIR ...................................... OFF
PACKS ......................................... ON
APU ......................................... STOP
```

```
======================================
                 CLIMB
======================================

ALTIMETERS ................................... STD
PTU .......................................... OFF
PRESSURIZATION ..................... ΔP BUILDING
LIGHTS ....................................... OFF
FASTEN BELTS ............................. AS REQD
```

TAKE OFF

```
=====================================
              DESCENT
=====================================

PTU ......................................... ON
PRESSURIZATION ..................... LDG ALT SET
LAND FLAP ............................... AS REQD


=====================================
             APPROACH
=====================================

ALTIMETERS .................................. SET
FASTEN BELTS ................................. ON
STEEP APPROACH .......................... AS REQD
APU ..................................... AS REQD


=====================================
             LANDING
=====================================

GEAR ........................... DOWN 3 GREENS
BRAKES .................................... CHKD
FLAPS ..................................... CHKD
AIRFRAME ANT & DE-ICE ...................... OFF
LANDING LIGHTS ............................... ON


=====================================
           AFTER LANDING
=====================================

AIRBRAKES & SPOILERS ......................... IN
FLAPS ........................... ZERO SELECTED
LIGHTS .................................. AS REQD
STEEP APPROACH ............................. OFF
TRANSPONDER ............................. AS REQD
ENG ANT-ICE ............................. AS REQD
CONT IGN ................................ AS REQD
GENERATORS .............................. AS REQD
ENGINES ................................. AS REQD
```

DESCENT & LANDING

```
=====================================
              SHUTDOWN
=====================================

BRAKES ..................................... PARK
LIGHTS ...................................... OFF
PRESSURISATION .................... DEPRESSURISED
HYDRAULICS .............................. ALL OFF
GENS 1 & 4 ............................ OFF RESET
THRUST LEVERS ......................... FUEL OFF
FASTEN BELTS ................................ OFF
BRAKE FANS .............................. AS REQD
FUEL PUMPS .............................. AS REQD
ENG ANT-ICE ................................. ON
BEACON ...................................... OFF
TRANSPONDER ......................... STBY, 2000


=====================================
          LEAVING AIRCRAFT
=====================================

IRSs ........................................ OFF
MASTER SWITCHES ............................. OFF
BRAKE FANS .................................. OFF
ANTI-SKID & LIFT SPLRS ...................... OFF
FLTDK EMERG LIGHTS .......................... OFF
PACKS ....................................... OFF
APU AIR ..................................... OFF
APU ........................................ STOP
FUEL PUMPS .................................. OFF
GALLEY SWITCH .............................. SHED
LIGHTS ...................................... OFF
BATT ........................................ OFF
```

LEAVING AIRCRAFT

FLIGHT PROFILES

Take Off Profile:

After Take-Off Checklist

Flaps Zero:
> Set climb power
> Accelerate to climb speed
> Complete Air Switching

Initiate Flap Retraction:
> not below 400ft RA

$V_2 + 10kt$

Close in turn:
> Maintain at least 18° flap until on departure heading
> Maximum bank 30°

Positive Rate of Climb:
> Gear Up

50 – 60kt:
> Steering with Rudder only

V_1

V_R

Rotation Speed:
> Rotate smoothly (~ 4secs)

Climb Profile:

Level Off:
> 1000ft to go call
> Confirm acquire
> Confirm capture

Periodic Check:
> Repeat 10 000ft items

10 000ft Check:
> Pressurization
> Taxi / Landing Lights off
> Ice Protection
> Continuous Ignition
> Engines
> Central Warning Panel

Climb Checklist at lowest of:
> Standard Pressure Setting
> 10 000ft
> Cruise Altitude

After Take-Off Checklist:
> Once flaps zero

Climb Speeds

Below 8000ft	250kt (Bird Impact)
Long Range < 31 000ft:	
TOW < 41 000 kg	250kt to Mach 0.62
TOW > 41 000 kg	250kt to Mach 0.64
Long range > 31 000ft	Mach 0.66
High Speed	280kt to Mach 0.66
Steep Gradient	210kt

Climb Thrust

CLIMB NORM after Take-Off
CLIMB MAX when rate of climb falls below 1000ft/min

Cruise Profile:

Top Of Descent

Descent Checklist:
> 2-3mins before TOD

Pax Briefing

Approach Briefing

Prepare Briefing

Fuel Checks:
> Quantity
> Fuel Used
> Transfer

System Checks:
> Hydraulics
> Electrics
> Air Conditioning
> Pressurization
> Central Warning Panel
> Engines

<u>Cruise Speeds</u>

Long Range (RJ70 & RJ85)   235kt / Mach 0.68

Long Range (RJ100)   240kt / Mach 0.68

Intermediate Cruise V_{MO} / Mach 0.7

Maximum Cruise power is CLIMB MAX!
Do not cruise at speeds below the
long range cruise speed!

Descent Profile:

Descent Speeds

Long range	250kt / Mach 0.60
High speed	290kt / Mach M_{MO}

RAD ALT:
> Announce 2500ft

MSA:
> Confirm position

Top Of Descent

Pax Briefing

Descent Checklist
> 2 - 3min before TOD

Prepare Briefing:
> Approach charts
> Check fuel
> Calculate arrival fuel
> Determine landing weight
> Set speed bugs
> Set OAT on TRP

Approach Briefing:
> TOD
> Weather and NOTAMS
> STAR and approach
> Missed approach
> Route to alternate
> Use of APU/eng air
> Use of ICE PROT and CONT IGN
> Taxi routing

ILS Approach Profile:

Descend outbound:
> Flap 18°
> Reduce to 160kt but not below V_{REF} + 30kt

Approaching GS intercept:
> Flaps 24°
> Reduce to V_{REF} + 20kt

Outer Marker:
> Locator
> DME
> Landing flap (33° or 24°)

Checklist Complete

Landing assured:
> Airbrake out
> Reduce to target threshold speed

GS 1 to 1.5 dots up:
> Gear down
> Landing Checklist

Localiser Intercept

PERFORMANCE DATA

This chapter gives some of the aircraft's critical performance data such as speeds and weights.

Maximum Weights

There are four maximum weight limits:

MRW The maximum total weight authorized or maximum ramp weight

MTOW The maximum take-off weight. This is the maximum allowed weight at the start of the take-off run

MLW The maximum landing weight

MZFW The maximum zero fuel weight. This is defined as the loaded weight of the aircraft minus the fuel weight

RJ70	Maximum Weights	
Units	kg	lb
MRW	43318	95500
MTOW	43130	95000
MLW	37874	83500
MZFW	33792	74500

BAe146-100	Maximum Weights	
Units	kg	lb
MRW	38328	84500
MTOW	38136	84000
MLW	35153	77500
MZFW	31071	68500

RJ85	Maximum Weights	
Units	kg	lb
MRW	45359	100000
MTOW	45173	99500
MLW	38555	85000
MZFW	34020	75000

BAe146-200	Maximum Weights	
Units	kg	lb
MRW	42410	93500
MTOW	42184	93000
MLW	36741	81000
MZFW	34020	75000

RJ100	Maximum Weights	
Units	kg	lb
MRW	46266	102000
MTOW	46039	101500
MLW	38555	85000
MZFW	36515	80500

BAe146-300	Maximum Weights	
Units	kg	lb
MRW	44452	98000
MTOW	44225	97500
MLW	38329	84500
MZFW	36515	80500

Maximum Operating Speed

The table below gives the Maximum Operating Speed by aircraft series:

Maximum Operating Speed		
Series	kt	Mach
RJ70 / BAe146-100	300	0.73
RJ85 / BAe146-200	300	0.73
RJ100 / BAe146-300	305	0.73

Flap Maximum Airspeed

The table below gives the maximum speed for extending the flaps and flight with flaps extended:

Flap Airspeed Limits (kt)			
Flap Angle	RJ70 / BAe146-100	RJ85 / BAe146-200	RJ100 / BAe146-300
18°	205	215	220
18° Max for holding	170	175	175
24°	170	180	180
30°	160	170	170
33°	150	150	155

Landing Gear Maximum Airspeed

We distinguish between two limiting speeds for the landing gear:

V_{LO} is the maximum speed at which it is safe to operate (extend or retract) the landing gear

V_{LE} is the maximum speed at which it is safe to fly with the landing gear extended

Both speeds are **210kt** IAS (Indicated Airspeed) for all variants (RJ70,RJ85 & RJ100).

Do note that landing gear operation is only safe below 20 000 ft.

Maneuvering Speeds

The Maneuvering Speed is the maximum speed for full control surface deflection without risking any damage. If flying above the Maneuvering Speed, control surface deflections must be reduced to avoid damage.

Design Maneuvering Speed		
Series	Flaps Retracted	Flaps 18°
RJ70 / BAe146-100	235	170
RJ85 / BAe146-200	235	175
RJ100 / BAe146-300	245	175

Maximum Operating Altitude

The maximum operating altitude is **FL350 for all Avro RJ variants** and **FL330 for the BAe146-series.**

—INTENTIONALLY LEFT BLANK—

CONFIG OPTIONS

QualityWings Options

In addition to the "On the Fly" options available via the QualityWings Control Panel, there are over 100 other options that can be set via a configuration file. The config file (QW146.cfg) can be found in the QualityWings folder within the Flightsim folder:
\Flight Simulator 9\Qualitywings\QW146.cfg
\Microsoft Flight Simulator X\Qualitywings\QW146.cfg

By default, the QW146.cfg does not have any options set (it is empty!). If the option is not in the cfg file, the default value for a given parameter is always used.

Available Options and Descriptions
There are 2 types of options:
Enable/Disable Type Options and Variable User Customizable Options.
Enable/Disable type options require either "0" or a "1" to set the option.
Variable User Customizable Options allow you to tweak (preset) certain options to your personal liking (within specified limits).
Notes:
- Leaving an option file blank sets an option of zero "0". This can cause confusion between values where "0" is used to disable and where "0" can be used to set a parameter. If you do not intend to set an option, make sure it is not in the QW146.cfg file.
- // in front of an options cancels option and uses default

* blue Config options are newly added options in Service Pack 1
* green Config options are newly added options in Service Pack 2
* pink Config options are newly added options in Service Pack 3
* light blue Config options are newly added options in Service Pack 4

GENERAL OPTIONS
Enable/Disable Type Options

Option	Description
DisplayLdgChkLst=1	Displays landing checklist on lower EADI, when landing checklist is activated on QW control panel.
Irs=1	Aligns IRS's on aircraft load. Default is 0
LdgChecklist=1	Activates Landing Checklist feature on aircraft load. Default is 0
LiteMode=1	Load Aircraft in Lite Mode config. Default is 0
LoadPanelStateonAcLoad=0	Disables the automatic loading of the LastSavedPanelState.pnl file (or defined PanelState= file). '1' enables automatic loading and is default.
Packs=1	Turn packs on, on aircraft load
SetSpdOffwhenAPMasterSetOff=1	Turns off speed hold automatically whenever the autopilot is disengaged.
SavePanelStateonFlightSave=0	Saves the panel whenever the flight gets saved (on by default)
LoadFuelOnAircraftLoad=	Disables automatic fuel loading on aircraft load(Fuel amount from QW Dispatcher)
LoadFuelOnFlightplanLoad=	Disables automatic fuel loading on flightplan load (Fuel amount from Flightplan)
ShowPushBackTruck=	Disables modeled Pushback Truck (on by default)
ActLnavWoIntHdg=	Enables LNAV to be activated without being on intercept heading
FmsAlwaysOn=	FMS always on, even if no power available
WeightUnit=LBS	Sets units to LBS. Default is KGS
SetTakeoffTrimOnACLoad=1	Sets the elevator trim to the approximate Take Off position upon aircraft load
SetHdgBugToAcHdgOnButtonPress=1	Sets heading bug to planes current heading when HDG is pressed on.
FullThrottleLockThrustMode=0	Disables throttle lock at times for finer tuning of N1 Ref.
EADITapeColor=R,G,B	Sets speed, and VS tape color on the EADI.
CRTDisplay=0	Turns off the CRT look in favor of a black background for the EHSI/EADI.
BankHoldInhibit=	Disables Bank Hold. '1' disables it. (BAe146 only)
PitchHoldInhibit=1	Disables Pitch hold. '1' disables it. (BAe146 only)

Variable User Customizable Options

IrsAlignSecs=17	Length of time in seconds to align the IRS's (default is 17)
PanelState=xxx.pnl	Panel state file to use every aircraft load (This file is not used if the situation matches the LastSavedPanelState.pnl file).
simver=9	Set simulator version (should only be used if aircraft is not correctly finding sim version by default)
TcasVertRange=	Default TCAS vertical range (in hundreds of ft) Default is 3000
AutoLandAPDiscSpd=	Speed where Autopilot gets disconnected after Autoland (85 by default)
QwPasSafetyDemoMinRwyDist=	Sets the Minimum distance (in feet) from the Departure runway that triggers the safety demo announcement (default is 3000 ft).
QwPasFASeatedRwyDist=	Sets the Minimum distance (in feet) from the Departure runway that triggers the Flight attendant announcement (default is 1500 ft).
AsiPopupIdent=	Sets the panel Ident of Primary instrument popup windows (to allow the user open the primary gauges in a group or individually)
EadiPopupIdent=	see above
AltPopupIdent=	see above
VsiPopupIdent=	see above
EhsiPopupIdent=	see above
RdmiPopupIdent=	see above

FMS OPTIONS

Enable/Disable Type Options

1xAtTod=1	Automatically changes to 1x sim rate on reaching TOD
PauseAtTod=1	Automatically pauses the sim on reaching TOD
ArmPauseAtTod=1	Arms Pause at TOD. Arming means its available in the FMS, but off,. and pressing the appropriate LSK will toggle it on.
Arm1xAtTod=1	Arms 1x at TOD. Arming means its available in the FMS, but off,. and pressing the appropriate LSK will toggle it on.

Variable User Customizable Options

FmcDispDragReqMsg=0	Disables 'DRAG Required' FMC message in VNAV mode
TransAlt=	Preset Transition altitude
ClbAltRest=	Preset Climb Altitude restriction (displays under Spd Rest label on FMS CLB page)
ClbSpdRest=	Preset Climb Speed restriction (displays under Spd Rest label on FMS CLB page)
ClimbIas=	Preset Climb Indicated Airspeed (displays under Sel Speed on FMS CLB page)
ClimbMach=	Preset Climb Mach speed (displays under Sel Speed on FMS CLB page)
CruiseIas=	Preset Cruise Indicated Airspeed (displays under Sel Speed on FMS CRZ page)
CruiseMach=	Preset Cruise Mach speed (displays under Sel Speed on FMS CRZ page)
DescAltRest=	Preset Descent Altitude restriction (displays under Spd Rest label on FMS DES page)
DescSpdRest=	Preset Descent Speed restriction (displays under Spd Rest label on FMS DES page)
DescentIas=	Preset Descent Indicated Airspeed (displays under Sel Speed on FMS DES page)
DescentMach=	Preset Descent Mach speed (displays under Sel Speed on FMS DES page)

GAUGE OPTIONS

Enable/Disable Type Options

ShowExtDestCtrlineRwyId=1	Displays runway identifier at the end of the extended runway centerline display in Map mode (EHSI)
DisplayExtRwy=1	Displays extended runway centerline
FlightDirectorType=	1 = Single Cue, 0 = Dual Cue

Variable User Customizable Options

DisplayFont=	Sets font used in FMS
EADISkyColor=R,G,B	Sets color of the EADI ADI sky portion (insert RGB numbers, Ex.: =100,151,249)
EADIGndColor=R,G,B	Sets color of the EADI ADI Ground portion
EadiRefreshRate=	Sets EADI refresh rate (per second), min is 1, max and default is 18.
EhsiRefreshRate=	Sets EHSI refresh rate (per second), min is 1, max and default is 18.
FmsRefreshRate=	Sets FMS refresh rate (per second), min is 1, max and default is 18.
PedRefreshRate=	Sets Primary Engine Display refresh rate (per second), min is 1, max and default is 18.
DefaultVerticalSpeed=	Sets default VS window value when new altitude is entered (Lite Mode only)
ehsi_crs_mode=	Sets CRS knob on EFIS control panel (1 – VL , 3 LNAV (2 not used).
Tcas=1	Sets TCAS On by default
tcas_knob=	Sets default position of tcas knob (0 off, 1 XPNDR, 2 TA/RA)
IasHoldMaxIasEngage=	Set the upper speed limit for the engagement of IAS Mode (default: 350)
IasHoldMinIasEngage=	Set the lower speed limit for the engagement of IAS Mode (default: 140)

SOUND OPTIONS

Enable/Disable Type Options
[Zero disables these sounds]

AltCallApprMins=0	Disables 'Approaching Minimums' altitude callout
AltCallMins=0	Disables 'Minimums' altitude callout
AltCall10=0	Disables '10' altitude callout
AltCall20=0	Disables '20' altitude callout
AltCall30=0	Disables '30' altitude callout
AltCall40=0	Disables '40' altitude callout
AltCall50=0	Disables '50' altitude callout
AltCall100=0	Disables '100' altitude callout
AltCall200=0	Disables '200' altitude callout
AltCall300=0	Disables '300' altitude callout
AltCall400=0	Disables '400' altitude callout
AltCall500=0	Disables '500' altitude callout
AltCall1000=0	Disables '1000' altitude callout
AltCall2500=0	Disables '2500' altitude callout
PlayCockpitSounds=0	Disables all the non sound.cfg cockpit sounds
PlayEventSounds=0	Disables event sounds (button clicks etc)
PlayGpwsSounds=0	Disables GPWS sounds
PlaySpoilersSounds=0	Disables the spoiler sound
PlayCoolingSounds=0	Disables the Equip Cooling sound
PlayPacksSounds=0	Disables the packs running sound
PlayGearDragSounds=0	Disables the Gear Drag sound
PlayAnnouncements=0	Disables QWPAS Announcements
PlayWarningSounds=0	Disables the Cockpit warning chimes
PlayTakeoffCalloutSounds=0	Disables the takeoff callout sounds (V1, Rotate, V2 etc)
PlayQWPASOutsideCockpit=1	Enables QWPAS outside of the cockpit view
PlayGPWSOutsideCockpit=1	Enables GPWS outside of the cockpit view
PlayAltCalloutsOutsideCockpit=1	Enables Altitude Callouts outside of the cockpit view

Variable User Customizable Options

VolumeCoolingFan=100	Sets cooling fan sound volume (min 1, Max 100) default 100
VolumeCrewCallouts=100	Sets Crew callouts sound volume
VolumeWarnings=100	Sets Warnings sounds volume
VolumePacksOn=100	Sets Packs running sound volume
VolumeSpoilers=90	Sets Spoilers sound volume
VolumeEvents=10	Sets Events sounds volume
VolumeGpws=100	Sets the volume of the GPWS sounds

SUPPORTED KEYPRESSES

KEY_TOGGLE_AFTERBURNER1	LNAV Button Press
KEY_TOGGLE_AFTERBURNER2	VNAV Button Press
KEY_TOGGLE_AFTERBURNER3	TCAS Knob (1 left mouse click, 2 right mouse click)
KEY_TOGGLE_PADLOCK	EFIS control panel APT button press
KEY_UNLOCK_TARGET	EFIS control panel NAV button press
KEY_TOGGLE_DAMAGE_TEXT	EFIS control panel GRP button press
KEY_TOGGLE_ENEMY_INDICATOR	EFIS control panel Map Range Increase
KEY_STOP_PRIMARY_GUNS	EFIS control panel Map Range Decrease
KEY_BAIL_OUT	EFIS control panel Format Increase (left click)
KEY_LETTERBOX	EFIS control panel Format Decrease (right click)

FREQUENTLY ASKED QUESTIONS

Why are the screens black, while everything else works?

   You probably forgot to switch on the AVIONICS MASTER Switches on the overhead panel.

I can't see the wipers in the 2D Panel. Is this a bug?

   The animated wipers only work in the virtual cockpit. If we added them to the 2D panel this would have significantly shifted the panel shortcuts and made the handling much less intuitive.

The Panel Flood light doesn't work in the 2D Panel!

   We haven't found a satisfying solution for this so we had to leave it out.

I can't engage the autopilot on the ground or shortly after takeoff!

   Autopilot engagement is not possible until above 400ft radio altitude, unless you operate the aircraft in LITE mode.

I can't find the Fuel Cut Off Switches. Where are they?

   They're fitted to the actual thrust levers. Simply right click below the respective thrust lever to cut off fuel (2D). In the VC you have to right-click the cut-off lever on the thrust lever. You can see this in detail in the quick start guide.

The thrust reversers don't work!

   The Avro RJ / BAe146 does not have any thrust reversers.

Can I add the default GPS or a third-party weather radar to the Virtual Cockpit?

   Yes. Simply add the following lines to the [VCockpit02]-section in the panel.cfg (Flight Simulator 9/Aircraft/QualityWings Avro Common/panel.RJ_HD):

   gauge36=fs9gps!gps_500, 442,482,395,327
   gauge37=QWings146!QW146_VC_WXR_Enable, 0,0,0,0

I don't like the Flight Attendant announcements (QWPAS). Can I disable it?

   Yes. Simply open the QW Control Panel and untick "QWPAS". You can also constantly disable it using the QW Config Options.

If my Navdata is outdated, can I update it?

   Yes. For more information visit *www.navigraph.com* and look for QualityWings Navdata.

Can I do anything to improve the Framerate?

   Yes. Have a look at the Config Options. They allow you to manually tweak the refresh rates of the gauges, which can lead to a better Framerate. For FSX we also offer non-QWHDT textures that reduce loading times and increase FPS for the cost of visual quality.

Where is the autobrake switch?

   The Avro RJ / BAe146 doesn't have an autobrake system. You have to brake manually.

Why are my Elevators pointing up? Is there any kind of control lock I need to turn off?

The elevators are tab-controlled, which means there are no hydraulic actuators that move them. They're only moved by the small control tabs you see at the trailing edge. By deflecting in the opposite direction of the desired elevator deflection, they move the control surface into the commanded position. Since this only works when the airflow around the elevator is fast enough, you'll see the elevator point up at low speeds.

—INTENTIONALLY LEFT BLANK—

ABOUT THE QW TEAM

The Ultimate 146 Collection Development TEAM

Corey Ford - CEO/Master Texture Artist/Designer Advisor
Country: United States
Bio: Corey got his start with the gold standard in flightsim groups 'Project Opensky' as a texture artist in 2006. He joined QualityWings in 2008. Responsible for Master Textures, Design advisor on the 757, Panel enhancements, and the User's Manual, he also handles most of QualityWings' day to day operations.

Lars Roennig - Lead Exterior Model Designer/Project Lead/Media Relations
Country: Germany
Bio: Another former 'Project Opensky' member. Lars joined QualityWings in October 2008. He has been responsible for the 757 and Avro RJ exterior model and took over the project lead for the Ultimate 146 Collection. With growing company popularity he also handles media relations.

Ernie Alston - Lead Gauges Programmer
Country: United States
Bio: Ernie is our lead programmer and has been programming FMC software for ages. His ISG FMCs are extremely popular within the FlightSim Community as well as his FSBuild Flightsim Plan Building software. He joined QualityWings in August 2008.

Jacob Kubique - Virtual Cockpit Designer
Country: Australia
Bio: Another 'Project Opensky' member, Jacob joined QualityWings in March of 2008 and was developing the Virtual Cockpit and 2D Panel for the 757 series. Jacobs Virtual Cockpits are among, if not THE best in the FlightSim Community (if we may say so ourselves).

Samy Fay - Lead Master Texture Artist
Country: Canada
Bio: As well as most of the rest of the team, Samy started his Flight Sim Career at 'Project Opensky' as a Texture Artist. Samy is known for his second-to-none attention to detail and dedication to make things as accurate as somehow possible. He joined QualityWings in January 2011.

Emil Serafino - Sound Designer
Country: United States
Bio. Another FlightSim community veteran who has his roots at Project Opensky. Emil joined QualityWings in April 2008 and has applied his unmatched Sound developing skill to the 757 series and the Ultimate 146 Collection.

Nick Peterson - Flight Dynamics Editor
Country: United States
Bio: A certified Boeing 757 pilot, Nick helped develop the 757 Flight Dynamics, helping to bring a high level of realism to the 757. How convenient, and actual 757 pilot who also happens to be a Flight Dynamics veteran!

Stefano Anedda - Founder/COO
Country: Italy
Bio: Stefano founded 'CustomSim' which eventually became "QualityWings Simulations". For the 757 series, he built the base for the 757-200 series before focusing on the day to day operations of QualityWings.

Development Team Supporting Cast

Jakob Klein
Country: Austria
Bio: Jakob contributed sophisticated tools to enhance and optimize the FS9 exterior model.

Benjamin Van Soldt
Country: The Netherlands
Bio: Benjamin was responsible for the Ultimate 146 Collection User's Manual

Hans Hartmann
Country: Germany
Bio: Hans was responsible for the QualityWings Dispatcher

Flight1 Europe, Ltd.
This product is distributed by Flight1 Europe.

Beta Testing Team
Renzo Marcus, Kevin Yang, Kevin Weber, Geoff Cooper, Ben Fluth, Jay Gardner, Brian Kircher, Matt Martin, Eric Olsen, Kyle Schurb, Benjamin van Soldt

Additional Acknowledgements
A VERY Special Thanks to these people/groups who have helped immensely!

John Green
Lenny Zaman
René Pedersen
Jan Van Hecke
Hannah Solway
FLIGHT! Magazine

Interested in the Making Of The Ultimate 146 Collection?
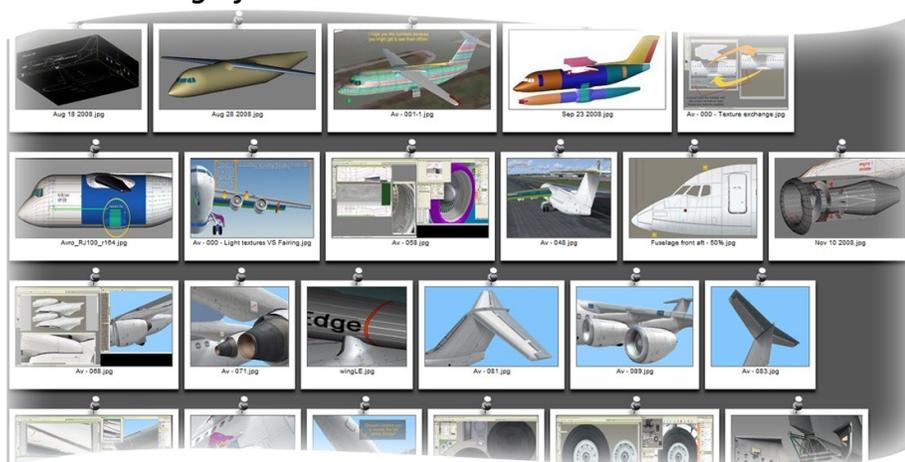
Our Master Painter Samy Fay has created a small Making Of, giving you some insights on the development of the textures. Make sure to check it out on:
https://www.facebook.com/media/set/?set=a.431668660208868.90424.431665620209172&type=3

—INTENTIONALLY LEFT BLANK—

SUPPORT

How to Obtain Support for your product

Should you need assistance with your product, please feel free to contact us on the Support Forums:

http://qwsim.flight1.net/forums

Technical Support requests will ONLY be handled in the SUPPORT FORUM for "The Ultimate 146 Collection".

Please be advised that the Tech Support Forum will only be accessible to **LICENSED MEMBERS** of this forum. Registered users will need to upgrade their forum accounts to **LICENSED USERS** before they can view the support forum to post topics and receive support.

To become a Licensed User after your purchase, first become a member on the QualityWings forums.

Support Guidelines

In order to better assist you, you need to be as SPECIFIC AS POSSIBLE as to the nature of your problem
In addition, the following information is REQUIRED in your post to receive support!
- What platform did you experience difficulties? FS9 or FSX?
- What operating System do you use?

Other information to consider providing:
- Have you recently made any changes to your PC (Hardware or software)

HELP US HELP YOU. Vague descriptions of problems will delay progress.

A quick Note to consider before requesting support

A LOT of time and effort has been put into developing this manual. Communication between the development team and the end-user (YOU) is paramount here at QualityWings Simulations, and hopefully that is reflected in the manner that this manual was put together. We ask that you CAREFULLY read this manual while you become familiar with the aircraft. We understand that you may want to just "jump right in"...and we have gone through great lengths to make sure that you can do that. But all good pilots put in some level of preparation before every flight. Do not be intimidated by the size of this manual. Information is VERY easy to find through the use of book-marks which are enabled by default.

Before you request support, we suggest that you check this manual carefully. While you request for support on issues that we have covered in this manual will not necessarily fall on deaf ears, let's just say your request for support may not occur as expeditiously as those with legitimate issues that have not been explained. Please do not opt for the quick answer - as it becomes annoying and increases the workload on the development team.

Happy Flying :-)
The QualityWings Development Team

GLOSSARY

This glossary was done with the awesome help of our community. Thank you!

A/C	Aircraft
A/P	Autopilot
A/T	Auto Throttle
AC	Alternating Current—Power supplied by engine or APU driven generators
ADF	Automatic Direction Finder—navigation system
ADI	Attitude Direction Indicator
AGL	Above Ground Level
APU	Auxiliary Power Unit
ATC	Air Traffic Control
BFO	Beat Frequency Oscillator
BRG	Bearing
BTI	Brake Temperature Indicator
C/O	Change Over (toggles between IAS and Mach)
CDU	Control Display Unit
CRS	Course
CSP	Central Status Panel
CTR	Center
CWP	Central Warning Panel
DBI	Distance Bearing Indicator—A combination of DME and RMI
DC	Direct Current—Power supplied by batteries or transformer rectifier units
DH	Decision Height
DME	Distance Measuring Equipment—measures distance from Aircraft to radio station
EADI	Electronic Attitude Direction Indicator
ECU	Engine Control Unit
EFIS	Electronic Flight Instrument System
EGPWS	Electronic Ground Proximity Warning System
EGT	Exhaust Gas Temperature
EHSI	Electronic Horizontal Situation Indicator
ENG	Engine
ESS	Essential Services Supply—Isolated electrical system for essentials
F/O	First Officer (same as Co-Pilot)
FADEC	Full Authority Digital Engine Control
FAF	Final Approach Fix
FD	Flight Director
FGC	Flight Guidance Computer
FGS	Flight Guidance System
FMS	Flight Management System
FPM	Feet per Minute—used to express rate of climb or descent
GEN	Generator, see AC
GNLU	Global Navigation and Landing Unit (same as FMS / CDU)
GNS-XLS	Global Navigation System (Same as FMS / CDU)
GPU	Ground Power Unit—provides AC power to aircraft
GPWS	Ground Proximity Warning System
GS	Glideslope (part of ILS)
GSPD	Ground Speed
GW	Gross Weight—current aircraft weight
HDG	Heading
HF	High Frequency—long range communication system

HMA	Hydro-Mechanical Assembly
HMU	Hydro-Mechanical Unit
HP	High Pressure
hPa	Hectopascal—Identical to Millibars
HIS	Horizontal Situation Indicator
HYD	Hydraulic
IAS	Indicated Air Speed
IGN	Ignition
ILS	Instrument Landing System—provides glideslope and localizer
INV	Inverter—provides AC power from DC supply
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International Standard Atmosphere. 1013.25hPa / 29.92 InHG and 15°C at sea level
LNAV	Lateral Navigation
LOC	Localizer (part of ILS)
LP	Low Pressure
LSK	Line Select Key, part of the CDU
MCP	Mode Control Panel
MCT	Maximum Continuous Thrust—power setting
MKR	Marker beacon. Outer, Middle and Inner markers.
MLW	Maximum Landing Weight
MRW	Maximum Ramp Weight—maximum total weight authorized
MSU	Mode Select Unit
MTOW	Maximum Take Off Weight
MZFW	Maximum Zero Fuel Weight— loaded weight of the aircraft minus the fuel weight
N1	Rotation speed of first engine stage (front fan)
N2	Rotation speed of second engine stage (core)
ND	Navigation Display (same as EHSI)
OAT	Outside Air Temperature
OEW	Operation Empty Weight—weight when empty, but incl. essentials (oil, survival equipment, etc)
PED	Primary Engine Display
PFD	Primary Flight Display (same as EADI)
PTU	Power Transfer Unit—transfers hydraulic pressure from yellow to green system
PWR	Power
QTY	Quantity
RECIRC	Recirculation (Air Conditioning)
RMI	Radio Magnetic Indicator
RNAV	Area Navigation
RNP	Radio Navigation Performance
RPM	Rotations Per Minute, often as percentage of rated speed
TA/RA	Traffic Advisory / Resolution Advisory—TCAS Announcements
TAS	True Air Speed
TAT	Total Air Temperature
TCAS	Traffic Collision Avoidance System
TMC	Thrust Modulation Control
TMS	Thrust Modulation System
TO	Take Off
TOC	Top Of Climb
TOD	Top Of Descent
TOGA	Take Off / Go Around—power setting

TR	Transformer Rectifier, see DC
TRP	Thrust Rating Panel
UTC	Coordinated Universal Time—also known as Zulu Time
V/S	Vertical Speed
VHF	Very High Frequency—main communication radio for civilian air traffic
VNAV	Vertical Navigation
VOR	VHF Omni-Directional Range—navigation system
WPT	Waypoint
XPNDR	Transponder—used to transmit aircraft details to Air Traffic Control radar screens
ZFW	Zero Fuel Weight—aircraft weight when loaded except fuel

VERSION HISTORY

Change Log (Version History)

Initial Release
Version 1 - FS9
Release Date May 20, 2012

Service Pack 1
Version 1.1
Release Date July 22, 2012

LIST OF FIXED ITEMS:

2D PANEL / SYSTEMS:
- Memory leak issue on some selected PCs
- FPS drop with TCAS on in 2D
- 2D Panel graphic revised for slightly increased EADI / EHSI size
- Disconnecting the AP during APP mode also disconnects APP mode for FD guidance
- No lateral FD Guidance when capturing localiser
- No IAS Hold before engaging the Autopilot once
- Using ALT HOLD to intercept glideslope, upon intercepting the ALT HOLD does not always extinguish
- When using LVL CHG, the AP automatically switches the mode to V/S when acquiring altitude
- When selecting LVL CHG on the MCP my selected altitude resets to waypoint restriction
- Not possible to select V/S mode without the autopilot on
- When engaging the autopilot, the heading display reverts to the current heading
- improved speed transition from CLB to CRZ speed in
- Autoland: AP disconnect speed should be 60kts instead of 85kts
- Autoland: Nose doesn't lower properly after touchdown
- Autoland: AT doesn't always retard throttles when flaring, which results in it hovering above the whole runway
- CRS 2 not possible to make big increments from e.g. 355 to 005
- Battery Amp-meter logic revised
- BATT NO CHARGE annunciator logic revised
- Brake Temp Indicator logic revised
- Fuel: Engine 1 & 2 stop when Left tank exhausted, despite common feeds and x-feed open
- Altimeter: Baro Press increments too unprecise
- Wing fuel quantity indicators should show the combined fuel of wing tanks and feed tanks
- Engines don't shut down when loading the Cold & Dark Panelstate
- Ovhd and Pedestal Text backlight remains on, although no power avail (GENs and BAT off)
- Avionics inop after some minutes on GPU/APU power
- TR1/2 gauges logic revised
- VOR1/VOR2 logic on audio panel revised
- BFO switches inconsistent in 2D / VC
- GPU-powered engine start enabled
- EHSI: When loading ATC Route, the first leg is not drawn correctly
- EHSI: Bearing pointer and VOR pointer don't show in MAP mode
- EHSI: APT display mode. Airport symbol too close to Airport ID's
- EHSI: Selecting SID after DEP RWY makes extended rwy centerline disappear (if config option is set)
- EADI: LBS units affect barber pole speeds
- CFG: LdgChecklist=1 config option doesn't work
- CFG: IrsAlignSecs= config option doesn't work

- CFG: FlightDirectorType=1 config option doesn't work
- CFG: ShowPushBackTruck=1 config option doesn't work
- CFG: Gauge refreshrates config options don't work
- FMS: Ability to insert PBD waypoints
- FMS: At-or-above / below restrictions not properly executed
- FMS: When an approach has more than one page of transitions in the database, only the first page is shown
- FMS: Not displaying the Fix page info in Map mode
- FMS: Approach waypoint alt restrictions not being adhered to in VNAV mode for 'at or above' restrictions
- FMS: APP Page , EHAM ILS06 Approach SUGOL transition, waypoints inserted into route incorrectly
- FMS: old SID doesn't get cleared when changing to a new SID
- FMS: loaded fuel always displays as LBS
- FMS: PROG 2 page always shows SAT as 0°C
- TRP: Master Engine Indicator logic revised
- Hydraulics AIR LO PRESS annun doesn't extinguish when loading a saved flight
- Flaps, roll spoilers, rudder and gear still work, although no hydraulic pressure available
- Lite Mode: HDG and LNAV Button Lights display at the same time
- Lite Mode: VS mode not disabled
- Lite Mode:NAV1 does not display as 'ON' when autopilot is on.
- Lite Mode: Thrust button does not display as 'ON' in IAS mode.
- Lite Mode: Autopilot should always activate on when pressed (it does not if the autopilot master switch is off).
- TCAS: Target display wrong color (displays as white it should be blue)
- NAV2 popup missing "X"-Icon
- Enhancement: Brake Fans AUTO function added
- Enhancement: Config option to set pitch trim to green band when loading plane (SetTakeoffTrimOnACLoad=1)

VIRTUAL COCKPIT:
- DH not adjustable above 2500ft RA
- The switches for Outer Wing Anti Ice and Inner Wing De Ice are interchanged
- Flightdeck windows can be opened in the air
- Engine Oil Indicators not assigned in the correct order
- Data Printer textures mirrored on FO side
- BATT NO CHARGE annun doesn't work
- GPS-Switch night lighting reads "MLS"
- Drawing order issue with light effects behind windshield
- NAV / VHF / ADF frequencies now adjustable directly via the knobs
- No Smoking switch night lighting does not work
- Impossible to select the V1 speed from the VC

SOUNDS:
- Continuous click sounds when playing a recorded video using FS Recorder
- AP Disconnect sound plays three times instead of twice
- Flap Handle sound plays when user wants to retract although already in UP detent
- Alt capture sound missing
- Too Low Gear, and Too Low Flaps sounds are missing
- Some altitude callouts missing (400, 200, 50, 30, 10)
- Packs: The flow sounds even play, when no Air Supply is provided
- QWPAS: Allow to play subsequent modes, if Mode 10 hasn't been triggered
- QWPAS still plays, although disabled in controlpanel and config option set
- Flaps howl sound does not trigger when the flaps are controlled by an axis in FSUIPC
- When setting the parking brake with CTRL+period, the click sound doesn't play

EXTERIOR MODEL:
- Black rubber seals and hydraulic lines can disappear in some occasions
- Engine covers now only show with engines shut down
- Wheel chocks now only available if parking brake is set
- Wheel chocks now only available on the MLG wheels

FLIGHT DYNAMICS:
- Flap lift and approach AOA revised
- Station load now affects CG

Service Pack 2
Version 1.2
Release Date October 21, 2012

LIST OF FIXED ITEMS:

2D PANEL / SYSTEMS:
- Standard aspect ratio main panel bitmap not showing
- PTU can pressurize green system, although yellow system unpressurized
- STBY GEN not always working
- SAT should be the static air temperature
- Lift Spoilers deploy with AntiSkid OFF
- the '40' callout, doesn't reset above 1000ft
- When lower MCP Alt selected, plane starts to descend prior to TOD
- No flap howl when controlling the flaps through FSUIPC
- QWPAS: Sounds play even though you switch them off
- FMS Progress page only displays 3 digits, cutting off the 4th when distance is more than 1000NM
- VNAV TOC calculation in FMS does not match TOC position displayed in EHSI
- FMC Perf Init page: When entering forecasted cruising altitude temperature in T/C OAT field nothing happens
- "Glideslope" callout missing
- Airplane descents in alt hold after new alt selected on MCP
- Saved Panel: Beacon Lights Switch not being set when loaded from saved panel file.
- FMS: incorrect climb alts when ILS approach is selected before STAR.
- Altimeter: Alt bug only settable in steps of 100'
- Lateral mode issue when switching from VOR/LOC to another mode
- FMS, Legs Speed only restriction not being accepted
- CFG, FlightDirectorType=1 setting being overridden by QW control panel
- FMS FIX page, Fix does not display on Nav display unless both radial and distance are set
- TCAS lateral range fixed at 10nm.
- RDMI right selector toggles between VOR2, and ADF1
- MCP not correctly switching from VOR/LOC mode to other lateral modes
- Vertical FMAs don't display on EADI with FD engaged, lateral are fine
- Packs sound play, although engines / APU are not running
- Fuel System: FUEL LO PRESS annuns shouldn't illuminate if wing tanks are empty and CTR TANK TRANSFER is on
- ALT HOLD: Aircraft Descends immediately after entering new alt in window without V/S engaged
- Brake Temperatures too cool
- TCAS Gauge should show range arc when in STBY
- default FSX GPWS warnings suppressed
- NEW ADDITION: PFD / ND dimmable

VIRTUAL COCKPIT:
- Baro Knob does not work with mouse wheel
- Oil pressure indicators don't reflect correct engines
- FO Glareshield annuns text mirrored when annuns not lit (FSX)
- Pedestal window clickspots inop (FSX)
- Some Ovhd Annuns misaligned (FSX)
- DROP OUT OVRD OXYGEN sticker on FO side mirrored (FSX)
- Parking Brake handle not animated when parking brake message disabled
- Displays not lit in dusk/dawn conditions (FSX)
- TRP V1 label only reads "V" (FSX)

FLIGHT DYNAMICS:
- Flap lift slightly revised (FSX)
- Contact Points slightly revised (FSX)
- V_{mo} revised

Service Pack 3
Version 1.3
Release Date October 12, 2013

NEW ADDITION:
-BAe146-100 / -200 / -300 variants
-Sperry Autopilot
-Honeywell GNS-XLS
-Thrust Modulation System

LIST OF FIXED ITEMS FOR AVRO RJ:

2D PANEL / SYSTEMS:
- FMS: Crash due to limited approach procedure names
- Overspeed warning missing

NEW ADDITION:
- Support for Fly-over waypoints

Service Pack 4
Version 1.4
Release Date December 22, 2013

LIST OF FIXED ITEMS:

EXTERIOR MODEL:
- BAe146-200 exterior model misses tailstrike protection (FS9 only)
- Wheel Chocks do not show if the parking brake message is disabled (FS9 only)
- No lit gearbay (FSX only)

2D PANEL / SYSTEMS:
- Crash to Desktop issues
- BAe146: Gauge backlighting does not work (FS9 only)
- Altimeter knobs & bugs missing (FS9 only)
- EHSI drawing offset when CRTDisplay=0 config option set
- Fire Ext Annunciators don't extinguish after Annunciator Test (upper overhead panel)
- FMC not interpreting Approach information correctly (e.g. EGLL ILS27)
- FMC ISA DEV in degrees Fahrenheit indicates 32 too high
- IRS panel not present in Avro RJ
- Avro RJ missing FGC clickspot. Misplaced clickspots in the same spot on overhead panel.
- ILS capturing problems
- V/L disarms when a different vertical mode is selected
- Toggling VS causes LNAV to not follow the track anymore
- Pressurization System builds up pressure when on ground
- TMS authority too small
- BAe146-300: PFD Dim knob missing in 2D
- BAe146-100/-200: Fuel Qty Gauges show wrong values
- BAe146-200: Fuel Used Indicators show total fuel used instead of fuel used per engine
- GNS-XLS: Manual flyover option on Database Wpt page missing
- GNS-XLS: Several buttons do not work after saved panel State is loaded with FMS on
- GNS-XLS: arrival Rwy page (8/10) does not show Frequency when ILS approach is selected
- GNS-XLS: arrival Rwy page (8/10) does not show selected Runway, after Approach is selected on Approach Page
- GNS-XLS: no 'Load Fuel' option

VIRTUAL COCKPIT:
- Parking brake handle in VC does not move if the parking brake message is disabled (FS9 only)
- BAe146-100/-200: HSI Text ("Miles" & "GND SPEED") overlaid by other text snippets
- BAe146: NAV2 window only partially lit
- MCP rotary knobs very slow in VC

SOUNDS:
- Occasional engine sound distortion in exterior view
- Flap retraction sound plays on ground when A/C has not been airborne after flap extension

FLIGHT DYNAMICS:
- TGT overall too cold

NEW ADDITIONS:
- Lite mode: PITCH UP/DOWN buttons adjust target V/S. Target V/S indicated on VSI
- IAS mode: Config options to allow user to set min/max IAS engagement speeds