Aerosoft DHC-6 **Twin Otter**

There is a big world waiting for you to explore. What better aircraft to do than a Twin Otter?

CONTENTS

ABOUT THE MANUAL

For the production of this manual, I was allowed to use the great book Twin Otter "You have Control" by Rolf Fritzer, Andre K. Aepfelbach, and Klaus Krampitz. They share the copyrights with Aerosoft. Andre Aepfelbach or Klaus Krampitz copyrighted all pictures and graphics unless otherwise indicated.

This manual differs from other manuals because it is written to be read as a book. It contains a lot of information you will not 'need' to fly the Twin Otter but will be either informative, entertaining, or will provide a background that will help you understand the Twin Otter better.

The manual consist of 4 sections:

1. An introduction to the Twin Otter
2. A description of the systems
3. A general description of how a flight is planned and performed
4. Two demo flights for you to follow

A few appendixes also assist with hardware configuration and offer more information.

A quick search on the Internet will find your dozens more DHC-6 manuals and documents!

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A special mention to tester Jake, who went out of his way to assist us with feedback on the flight model, recorded sounds and basically made this project much better. Testers Travis, Sven, Erik V. and Eric B also did contribute tremendously to this project.

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SYSTEM REQUIREMENTS

- Windows 10 or 11 (fully updated)
- Microsoft Flight Simulator (version 2020)
- Processor: Intel i5-8400 | AMD Ryzen 5 1500X
- Graphics: NVIDIA GTX 970 | AMD Radeon RX 590
- Memory: 16 GB
- Diskspace: 1.6 GB
- **Internet connection required for activation**

SUPPORT

Support for this product is offered by Aerosoft. We prefer to have a support forum for the simple reason that it is fast and efficient because customers help customers when we are sleeping.

https://forum.aerosoft.com/index.php?/forum/1046-aerosoft-twin-otter/ Please use the correct forum section so things do not get lost/

If you prefer email via support, you can leave a ticket at https://helpdesk.aerosoft.com/portal/en/home, and we will reply by email. Product support is not given by telephone.

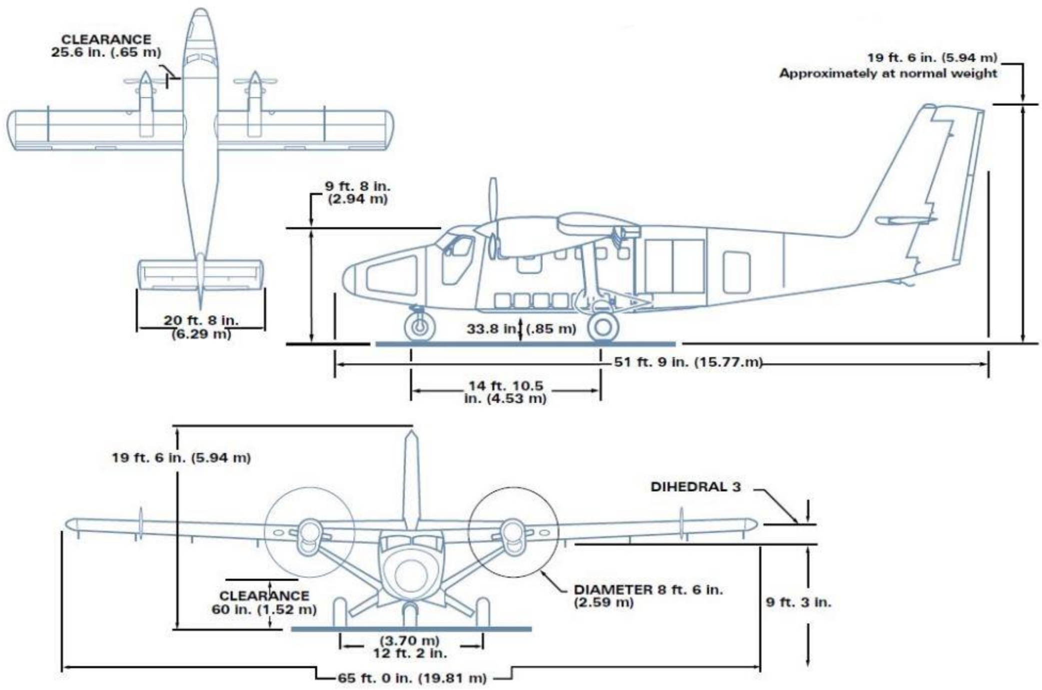
We feel strongly about support. Buying one of our products gives you the right to waste our time with questions you feel might be silly. They are not.

INTRODUCTION

At first glance, the DHC-6 is a very atypical aircraft. Most turboprops have retractable landing gear and unsupported wings - the Twin Otter does things differently. The landing gear is rigid, and the wings are reinforced by struts. So, it is an aircraft that does not fit into any box, and perhaps this is the secret and the reason the Twin Otter is still in service today around the world.

The Twin Otter was originally developed by de Havilland Canada, based on the then single-engine DHC-3 Otter, which was fitted with a longer fuselage and a pair of Pratt & Whitney PT6 engines for testing purposes. The engineers' idea was to develop an aircraft based on the DHC-3 that increased payload capacity and was safer using two engines while keeping the short takeoff and landing characteristics.

By using several DHC-3 parts, such as wing components, de Havilland Canada was able to keep production costs low and completed Canada's first propeller-driven turbine aircraft on May 20, 1965. The Twin Otter performed well in regional commuter service and contributed significantly to the success of the local airline industry, not least due to the robust and reliable PT6A engines.



After the production of the 300 series was stopped by de Havilland Canada in 1988, the company Viking Air in Canada took over the production. It introduced the new DHC-6-400 with modern avionics in 2010.

AREAS OF OPERATION

The Twin Otter is being successfully used as cargo, passenger, firefighting, medevac aircraft, and a drop plane for parachutists worldwide. Since the DHC-6 can be equipped with various landing gear configurations, it is often used in hard-to-reach places such as Alaska, Africa, Australia, or Antarctica.

Originally developed as a pure bush plane for use in Canada's north, the Twin Otter is now home at airports, beaches, north and south poles, grass fields, snow, ice, mud, mountain tops, and water. A true go-anywhere aircraft. It has great STOL capabilities due to the design of the wings, sturdy undercarriage, and twin turboprop engines. It is the only connection with the rest of the world for many isolated communities, and Twin Otters

have been known to carry anything. It is an aircraft that saves lives. It is also an ideal aircraft to explore the vast world of Microsoft Flight Simulator because it flies low and relatively slow.

The use of the DHC-6-300 has proven particularly successful on unpaved runways. On Warraber Island, in the Torres Strait between Australia and Papua New Guinea, the Twin Otters were used for island hopping with their short takeoff and landing characteristics. From Warraber Island, pilots usually continued to surrounding islands for daily resupply. In addition to people transported between the islands, the cargo often consisted of materials and basic foodstuffs. Torres Strait Islanders were taken to the hospital on Thursday Island for medical care.

STOL

STOL is the abbreviation for Short Takeoff and Landing. The Twin Otter is designed for short runways; it requires a takeoff distance of 1,200 feet (366 m) and a landing distance of 1,050 feet (320 m), making it the optimal aircraft for short runways around the world.

The Twin Otter is the optimal workhorse for unpaved runways. Even on the grass runway of Murray Island with a dimension of 525 x 30 meters, it is still possible to transport 12 passengers, including luggage. An airline regularly served Horn Island from Murray Island Airport (YMUI). Thus, a connection to Cairns on the Australian mainland is also possible via this hub.

A typical approach configuration here is 20-degree flaps and an approach speed of about 75 KIAS. Especially during the rainy season in the tropics, care should be taken not to use too much wheel braking during landing but rather more reverse thrust. The runway's surface is often rough, and there may still be large amounts of water on the runway. In addition, the runway can also be very soft due to prolonged rain.

Pilot Peter M. was relaxing at an airport in the USA when two older DC-8 captains approached him and said: "Hey Sunny Boy, we flew the exactly same Twin Otter years ago in Florida and tell you what you should try. Put the flaps on full flaps and set the parking brake. Set full power and release the brake, keep the nose of the Otter on the ground as tight as you can, and as soon as you're a little airborne, retract the flaps all at once." No sooner said than done - Peter was in the air in no time. Try it.

SPECIAL FEATURES

A special feature of the Twin Otter is certainly the engine control and the control of the flaps, which are located on the overhead panel. This distinctive feature has the advantage that the Bowden cables (connecting the controls to the engines) do not have to run between the controls on the cockpit floor and the engines on the wings, but rather along the shortest possible path. This arrangement makes maintenance easier and reduces malfunctions.

Another feature is the simplicity with which the DHC-6 was designed. For example, the only hydraulically powered systems are those of the flaps, which can be controlled from the 0 to 37.5-degree position, and parts of the brake system.

The Twin Otter is an aircraft without a pressurized cabin, reducing the weight of the fuselage. Incidentally, it can also fly without doors, for example, to drop parachutists or goods, and as the tail is high, there is little risk of hitting the horizontal tailplane.

The Twin Otter was designed as single-pilot aircraft and can be fully operated from the left seat; in most countries, however, is it seen as too heavy to be a single pilot aircraft, and a co-pilot is required.

IF YOU WANT TO FLY RIGHT NOW

We understand that not everybody wants to read this whole book before starting the aircraft, so we have compiled some brief information that is essential for flight.

First of all, use the checklist system built into the sim. You will be able to use all systems as they should be, and you will have no surprises.

Then stick to these speeds and settings for each stage of the flight. **Speeds matter; they matter a lot.** At 70 knots, you might be flying; at 68 knots, you might be dropping out of the sky.

Takeoff - Flaps	10° flaps, V1 73 KIAS, V2 80 KIAS (up to 400 feet above ground).
Climb	After the flaps have been retracted, the best rate of climb is at 100 KIAS.
Landing approach	Not less than 94 KIAS when flaps are retracted. Not less than 85 KIAS with flaps at 10°.
Landing	Flaps 20°, Vref 80 KIAS or Flaps 37.5° Vref 74 KIAS.

Assuming temperatures ISA +6 degrees at sea level in the cruise phase, 50 PSI Torque can be set. However, this is usually not done as it means quite high fuel consumption but hardly any increase in TAS (True Air Speed). Therefore, most Twin Otter operators choose a power setting of 45 PSI and a propeller speed of 75% Np. This results in 300 lbs per engine fuel consumption and is a good compromise between fuel consumption and speed.

Best Rate of Climb	100 KIAS, Flaps retracted
Best Angle of Climb	87 KIAS, Flaps retracted
Best Single Engine Rate of Climb	80 KIAS, Flaps 10°
Engine Failure after Takeoff	80 KIAS, Flaps 10°
Enroute Descent	Flaps 0°, speed limited by Maximum Operating Speed
Minimum Control Speed, One Engine Inoperative	64 KIAS, Flaps 10°
Stall speed, landing configuration	(Flaps 37.5°) - 56 KIAS
Stall speed, takeoff configuration	(Flaps 10°) - 66 KIAS
Stall speed, flaps up	73 KIAS
Manoeuvring Speed	132 KIAS Sea Level to 18,000 ft, limited by V_{MO} above 18,000 ft
Glide Speed	(Propeller feathered) best range - 100 KIAS
Glide Speed	(Propeller feathered) best endurance - 77 KIAS
Maximum Operating Speed	166 KIAS
Flaps Extended Speed	Maximal 103 KIAS with flaps 10°, maximal 93 KIAS with flaps above 10°

THE DHC-6 PRODUCT RANGE

The DHC-6 Twin Otter is probably one of the most versatile aircraft ever built. In addition to different variants, various versions with different equipment are also in service - these are explained in more detail here.

DHC-6-100

The original Twin Otter had the designation DHC-6-1, of which only 5 were produced.

This was followed by the DHC-6-100, which was produced from serial numbers 6 to 115. This Twin Otter had a larger door on the left side of the cabin (142 x 127 centimetres, as against 118 x 118 centimetres in series 1). In addition, one double seat per row was added on the right side in the passenger cabin, thus increasing the number of seats to 21. Series 1 and 100 were characterized by the "short nose" and a flap for the baggage compartment in the front part of the aircraft.

DHC-6-200

The 200 series was distinguished by a 0.68-meter longer fuselage nose, including a larger forward baggage compartment, an expanded cargo compartment in the rear, and wider cargo doors. Production of the 200, of which 115 aircraft were built, began in April 1968.

DHC-6-300

Introduced in 1969 with Twin Otter number 231, the 300 series is notable for its long nose (though there are some with the short nose) and, of course, more powerful PT6 engines, allowing an additional 1,000 lbs (450 kg) takeoff weight and 20 passenger seats. In the mid-1970s, the DHC-6-300S was built, bringing better STOL performance. Production of the DHC-6-300 was halted by de Havilland Canada in late 1988. The DHC-6-300 is certainly the best-known model of the Twin Otter series and can also be found in many areas of the world.

The D-IVER shown here is used for cargo flights in Europe, among other things. However, the 300 models are also predestined for operation in various climatic zones and are used in the Maldives as a tourist shuttle or in Canada for expeditions.

As Twin Otter enthusiasts, we consider the DHC-6-300 to be the most mature model, and its versatility offers plenty of variety for virtual pilots as well.

DHC-6-400

Canadian manufacturer Viking Air decided to build a new version based on the -300 in 2007, after a 20-year break in production.

Although the DHC-6-400 does not differ externally from its predecessor, the more powerful version of the Pratt & Whitney Canada PT6A-34 or optionally PT6A-35 with Hot & High Performance was installed. In addition to the standard landing gear, float, amphibian, ski, and wheel-ski landing gears are again offered, among others. In addition to the new engines, other components have also been brought up to state of the art. For example, plastic and a new cockpit with 4 displays and LED lighting have reduced the empty mass by 240 kg.

The prototype's maiden flight with construction number 845 took place on February 16, 2010, under CF-DHT registration. The first deliveries to customers also began in 2010. Now, we can discuss whether a glass cockpit belongs in a bush plane or whether the well-tried "clock store" should also be used in the more modern versions of the Twin Otter. On the one hand, progress is ongoing and does not stop at a DHC-6; on the other hand, it has to be considered how many hard landings a glass cockpit can withstand. This product does NOT include the 400 series.

SPECIAL MODELS OF THE DHC-6 TWIN OTTER

Although there is a suitable model of the Twin Otter for every terrain, companies always need special models. This section briefly examines the different series and discusses some interesting special models, such as the Vistaliner with oversized windows.

As a special unclassified model, we would like to present "Baby Stork" in this section. A Nepal Airlines DHC-6-300 with flight number RA-706 was en route from Bajura to Nepalgunj when 20 minutes after takeoff, a woman on board gave birth to a healthy baby boy unassisted. The pilots decided to continue the flight to Nepalgunj, and the mother and baby were taken to the local hospital after landing.

Although it is rather unusual to transport heavily pregnant women in an aeroplane, this expectant mother was on her way to the hospital in Nepalgunj due to the lack of medical care in her hometown. We do not know if the newborn has been granted Frequent Flyer status.

DHC-6 SERIES 300M/MR/S

Several variations in the 300 series are used for military purposes.

The DHC-6 Series 300M is a multi-purpose military transport, of which two aircraft were built as proof-of-concept demonstrators. The aircraft was specifically designed to transport paratroopers who could be dropped into inaccessible terrain. It also had a so-called external load station, a device to which weapons systems, for example, could be attached.

A maritime reconnaissance version for coastal surveillance was introduced in 1982 under the designation DHC-6 series 300MR. This Twin Otter had, among other things, a search radar under the nose and additional searchlights on the wings. Furthermore, the fuselage had outward curved observation windows. However, to our knowledge, only one 300MR was sold.

The manufacturer built a DHC-6 Series 310 for the BCAR (British Civil Air Regulations). Which deals with civil aviation issues in the UK.

The DHC-6 Series 320 is a modification of the 300, which was built in accordance with the Australian Civil Air Regulations.

CC-138

A very interesting and versatile version is the CC-138, used by the Canadian Forces as a transport and search-and-rescue aircraft. The designation CC, introduced by the RCAF in 1947, indicates a transport aircraft. With a range of 1,427 kilometres and a service ceiling of 8,000 meters, it is perfectly equipped for Canada's climate and natural environment. The four Canadian Forces DHC-6s based in Yellowknife can carry up to 20 passengers or 2,999 kilograms of cargo. All aircraft can also be converted from wheeled to ski or water configuration, making them suitable for use on virtually any surface.

VISTALINER

For tourist purposes, there is a so-called Vistaliner, which has larger windows but otherwise has a standard cockpit and layout. Such a Vistaliner is used, for example, by Grand Canyon Airlines in Arizona, USA, not least because of its ability to fly over the Grand Canyon at a relatively low speed of about 90 knots.

UV-18A/B/C

The UV-18A is a variant used as a utility transport aircraft for the United States Army and the Alaska National Guard. Six of these models were built, but the US Army has replaced them with the C-23 Sherpa. By the way, the turboprop can be optionally converted to floats or skis.

The UV-18A shown above is equipped with a crew and passenger oxygen system. Also, it has a special navigation and communications package that allows the crew to fly in all weather conditions.

The UV-18B has been used primarily as a training aircraft for the United States Air Force Academy paratroopers. In addition to training purposes, the Air Force Academy's 98th Flying Training Squadron uses its three DHC-6s for its Wings of Blue parachute team, which completes more than 19,000 jumps per year.

The UV-18C is also a military-use Twin Otter with a cruising speed of 150 knots, a range of 700 miles, and a service ceiling of 25,000 feet.

GUARDIAN 400

A brand-new model was introduced by Viking Air at the Paris Air Show in 2009. The company itself describes the new version as an aircraft that can handle even the roughest terrain with minimum maintenance in the ski, float, or wheel configurations. Intended primarily for coastal surveillance and SAR, the Guardian 400 has a searchlight and thermal imager on the nose and a radar system on the underside between the main landing gear.

The Vietnamese Ministry of Defense ordered six Guardian 400 Twin Otters in mid-2010. Some will recall the mysterious disappearance of a Malaysian Airlines B777 in March 2014, bound for China under the identifier MH370. The Vietnamese airline's new DHC-6-400s were also used in the large-scale search operation.

LANDING GEAR VARIANTS

As described above, the Twin Otter is an aircraft that offers clear advantages due to its versatility. Other landing gear versions replaced the standard wheel configuration to land in extreme locations worldwide. This enables the DHC-6 to land on water, ice, snow, and rough terrain.

WHEELS

The DHC-6 has a main landing gear with shock absorbers that absorb the high shock load from utilizing built-in rubber blocks and preventing bouncing. Disc brakes on the wheels provide a shorter braking distance. Tire pressure is normally maintained at 38 psi when the outside temperature is above -29°C, as the tires also absorb shock.

Apart from the aerodynamic disadvantages, the fixed landing gear on the Twin Otter has some plus points. Not only are the maintenance costs of a fixed undercarriage much lower than those of a retractable undercarriage, but many types of tires can also be installed on the Twin Otter or even the undercarriage versions mentioned. All this would be impossible with a retractable landing gear. Furthermore, the rigid landing gear is more robust and less susceptible to damage while landing on bush runways.

TUNDRA WHEELS

The tundra is certainly one of the most unpopular landing sites globally, as the surface of moss, stones, snow, and, in summer, the sodden permafrost soil often poses unpredictable dangers. As a rule, ski-wheel combinations are too weak to negotiate the holes hidden in the ground without damage. Therefore, pilots should avoid the tundra unless the landing area is known.

Tundra Wheels, also called Tundra Tires, are large low-pressure tires specifically designed for this rough terrain on light and medium aircraft. A special feature is certainly the so-called hydroplaning, where the aircraft's speed is slowed down by a slight touchdown on the water surface, thus greatly reducing the braking distance. Of course, this should be near an island or sandbank, from which one can also take off again after a successful manoeuvre.

Pilots should note that the Tundra Tires on the ground limit the forward visibility since the aircraft assumes a slightly tilted posture. Furthermore, the tires affect the flight speed, the climb rate, or the range, among other things.

FLOATS

The DHC-6 can also be used as a seaplane for islands or rough terrain operations. It is equipped with floats instead of tire landing gear, also known as floatplanes. The best-known companies that used the Twin Otter on floats for island services are Trans Maldivian Airways (TMA) and Maldivian Air Taxi (MAT), which merged into one company in February 2013.

The photo of the MAT Twin Otter shows how the floats are mounted with struts on the underside of the aircraft fuselage and act as steps when stationary. They are designed to enter a low-drag state ('on the step') when accelerating during takeoff, allowing the DHC-6 to quickly reach its takeoff speed. In the float version, the Twin Otter also has boundary layer fences on the wings to improve the flow separation behaviour on aircraft wings and auxiliary fins on the tailplane.

A special feature is the water bombing floats used in Canada, for example, to fight forest fires. The water intake and ejection doors are controlled by a separate hydraulic system. This version of the Twin Otter requires several modifications to the aircraft. This firefighting aircraft requires reinforced wings to prevent the wings from flexing due to the additional weight.

AMPHIBIAN

The Twin Otter Amphibian is equipped with a Landing Gear, which allows landing the aircraft on the water utilizing floats and in parallel to operate the aircraft on the land using a tire landing gear. The landing gear can be retracted into the floats in the rear segment and folded in the front segment to reduce air resistance.

A landing gear lever is used to extend or retract the wheels. LEDs in the panel indicate the landing gear position (green LEDs) and the active bilge pumps (blue LEDs).

The amphibious version has a deactivated Nose Wheel Steering Tiller and has no water rudders on the floats. Like the float version, it is steered in the water via differential power and on land via the differential brakes. Of course, this becomes a challenge on land and water at low speeds in slightly stronger winds.

In the left foot area of the co-pilot side is an emergency pump, with which you can manually extend the landing gear. However, this is not functional in the software.

Backup pump in the Amphibious version

The operation of an amphibious aircraft requires special experience, especially during the so-called ramping, which means getting the Twin Otter in or out of the water using a ramp on the shore that extends under the water surface. We recommend proceeding as follows when ramping:

When ramping from water to land, the landing gear should be extended just before the ramp yet promptly so that the floats do not touch the ground. The wheels can be extended earlier without using the REVERSE and in a strong tailwind to increase the braking effect. Of course, in any case, the wind must be taken into account; otherwise, the aircraft can easily land next to the ramp. When ramping into the water, the landing gear should be retracted as soon as the floats are free in the water to reduce drag here as well. Other docking procedures are described later in this manual.

SKIS

There are two different ski landing gears for use in snowy regions. On the one hand, there is a pure ski landing gear, which is used, for example, by Kenn Borek Airlines for its operations in Antarctica. On the other hand, there is a so-called wheel-ski setup, especially for areas that have a normal runway and the Twin Otter still has to land on ice and snow away from civilization. The skis can be lowered hydraulically by operating a lever in this version. This lever is located under the instrument panel on the pilot's side. Especially when landing on icy terrain, pilots have to pay attention to many things. After landing, for example, aircraft are usually parked at a certain point to allow the landing gear to cool down before they are allowed to manoeuvre to the final parking position. The purpose of this is to prevent the skis, which have been warmed by the landing, from sinking into the ice and the Twin Otter from being stuck so deeply in the ice or snow that it cannot be moved.

If you find a sturdy block of wood on board, it is most likely used to what the skis before taxi to make sure they are not frozen to the ground.

CABIN VARIANTS

Our multifunctional aircraft also leaves almost nothing to be desired in cabin configuration. The passenger variant, for example, can be converted quite easily for the operation of parachutists or cargo. The individual configurations are explained in more detail below.

PASSENGER CABIN

The seats in the passenger cabin can be arranged in various configurations using a rail system on the cabin floor. As standard, a two-track rail system is installed in the Twin Otter to accommodate 20 seats in the cabin.

The *luxury* variant

A three-track system is installed as an option, allowing various configurations (from 13 to 20 seats).

All passenger seats can be removed easily if the DHC-6 needs to be converted to a cargo version. The cabin can also be equipped with a wardrobe and toilet on special request. The picture above was taken in a DHC-6-400 with a lavatory and air conditioning installed as an option.

Although passengers tend to be a bit more demanding on pilots than the cargo they are carrying, Twin Otter pilots often recount many enjoyable experiences and stories. Especially as pilots in the Maldives, our friends report good-humoured tourists in a vacation mood, visibly enjoying the flight to their hotel islands.

The biggest challenge of any pilot is to work for an airline that instructs the crew to fly with aircraft that are not 100% functional. This is what happened to a pilot we know, whom we will simply call Earl because of the explosive nature of the text.

SKYDIVER

The parachutist version dismantles the cargo door, and the seats are removed. In addition, a roll-up door is installed, which is guided on plastic rails and can be easily opened upwards by the jumpers. A metal bar is installed in the door frame so that the jumpers can hold on there until they jump. Each skydiver has a harness about 30 cm long on the side of the board, which they must wear to a safe height during takeoff. In some skydiving cabins, benches are also installed along the side of the board to provide a little more comfort for the jumpers.

Earl had an intense experience when stationed in Connecticut, and a hurricane was approaching. There were no hangar or suitable tie-downs for the Twin Otter at the time. The day before, Earl had a problem with his hydraulic pump and had to abort the flight during the line-up and unload the parachutists on board with the chute closed again.

The following morning, the day of the actual hurricane, Earl's team leader wanted him to fly the DHC-6 out of the storm area toward Ohio and bypass the faulty hydraulic system with the Emergency Hydraulic Hand Pump. He followed the instructions and found himself a mile after takeoff in a zero-visibility environment with severe turbulence. Earl decided to turn around, land back on the airfield, and re-enter the line. After the second takeoff, he flew the Twin Otter in the other direction to reach the next airport with an available hangar. After a short flight, the pilot spotted the VASI (Visual Approach Slope Indicator) of the destination airport; however, everything around it was a whiteout - meaning that due to reflections, the ground and sky merged seamlessly. The tower cleared a Special VFR (special visual flight rules when weather conditions are no longer conducive to normal VFR) and told Earl to accelerate his approach sharply. He landed safely, although he was fiercely operating the Emergency Hydraulic hand pump the entire time. The DHC-6 was subsequently parked in a hangar and lashed down with ropes; mechanics secured the propellers with duct tape.

It was certainly an unusual and non-flying experience Earl had with the Hurricane and the faulty hydraulic pump. Yet, it speaks to the good flight characteristics of the rugged turboprop. It was the most frightening experience for Earl in all his years on the Twin Otter.

A green, orange and red signal light is installed next to the skydiver door. This can be operated by the pilot in the cockpit by pressing one of the three lights and signals to the jumper that they are now at the jump zone. The red light means NO GO, the orange light means STAND BY, and obviously, the green light means GO. The DAY/NIGHT switch sets the brightness of the lights.

Skydiver interior

Andrew McGill used to fly parachutists at the Sunshine Coast in Australia. He explains the procedure.

"The Twin Otter is the ideal aircraft for dropping parachutists. Due to the short takeoff and landing characteristics, the Otter can operate on short meadows and landing fields, and we can usually transport up to 20 skydivers. The jumpers then sit relaxed with their backs in the direction of flight on the carpeted floor. The cargo doors were previously removed and replaced with a roll-up door made of transparent plastic. This door protects the jumpers from wind and weather on the way to the jump.

The Twin Otter is launched with flaps 10 degrees, and the power setting is 50 PSI. After takeoff at an altitude of approximately 400 feet, the flaps are retracted, and we climb to flight level 140 (14,000ft) at approximately 90-100 KIAS. A maximum climb is required during the drop procedure, thus keeping turn-around times as short as possible. We fly a large oval up to the Run In (touchdown line); this avoids unnecessary turns and manoeuvres where you lose lift. Once you arrive at the run-in, you look at how the altitude winds behave. It is advantageous to release the jumpers into the wind to achieve a low speed over the ground. This gives the skydivers enough time to gradually exit the aircraft. The typical drop speed is 80 KIAS, and the flap position is 10 degrees.

With a headwind of 20 knots, it is possible to the drop point at 1.5 miles from the jump site. This allows jumpers to return to the drop zone safely under their canopy. When descending with the Twin Otter, maintain a constant KIAS of 160 as the VSI (vertical speed) is around 4,000-5,000 feet per minute; the power levers will usually be in the idle position. For the whole airdrop, you can plan about 20 minutes, which means that after a short time, you are back on the ground and ready to pick up new parachutists. A drop is an ultimate experience not only for jumpers but even for the experienced Otter pilot."

CARGO VERSION

The seats are removed in the cargo version, and, usually, the airstairs are replaced by a simple cargo door. This allows a forklift truck to drive up. The cargo floor is protected against damage by light aluminium plates or wooden boards. There are several rails on the floor to which belts with system hooks can be latched, so heavy objects such as boxes or pallets can be secured to the floor with tension belts.

Since the Twin Otter is a real freight donkey, it can transport many things. On a flight in North America, for example, it carried a couple of Harley-Davidsons, or a seaplane was used to transport roosters out of San Juan Harbor. Of course, the DHC-6 can also be loaded with hazardous materials for hard-to-reach areas. For example, pilot Craig flew dynamite through the area for an oil field exploration in Algeria.

SPECIAL FEATURES

In addition to the cabin variants listed above. For example, the cabin of military aircraft is often equipped with a passenger-cargo combination or specially designed cabins in which the crew can control SAR operations or military manoeuvres. DOOR VARIANTS

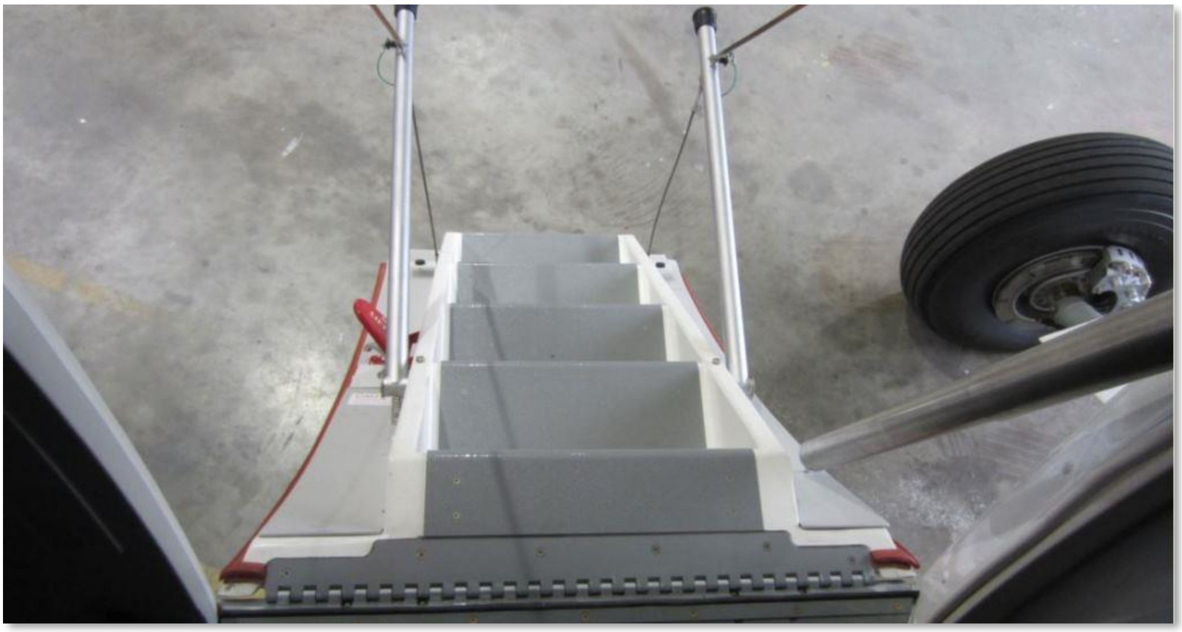
The Twin Otter has various exits and cargo hatches. A so-called Flight Compartment Door is available to passengers on each side of the aircraft for normal boarding and deboarding. This is a single cabin door on the right side, and on the left cabin side, there is a double door. This passenger door can be removed and replaced with another configuration. Therefore, we briefly describe the different variants. The doors and cargo hatches have small micro switches connected to the DHC-6 electrical system. The DOOR UNLOCKED warning light will illuminate the Caution Lights Panel if a door is not properly locked.

STANDARD DOOR / CARGO DOOR

We call the "standard" door the optionally available Cargo Door, which can be installed instead of the Airstair Door mentioned below. The door has a bracket for external ladders and, just like the so-called Airstair Door, a small window. To open the cargo doors, click the handle.

AIRSTAIR DOOR

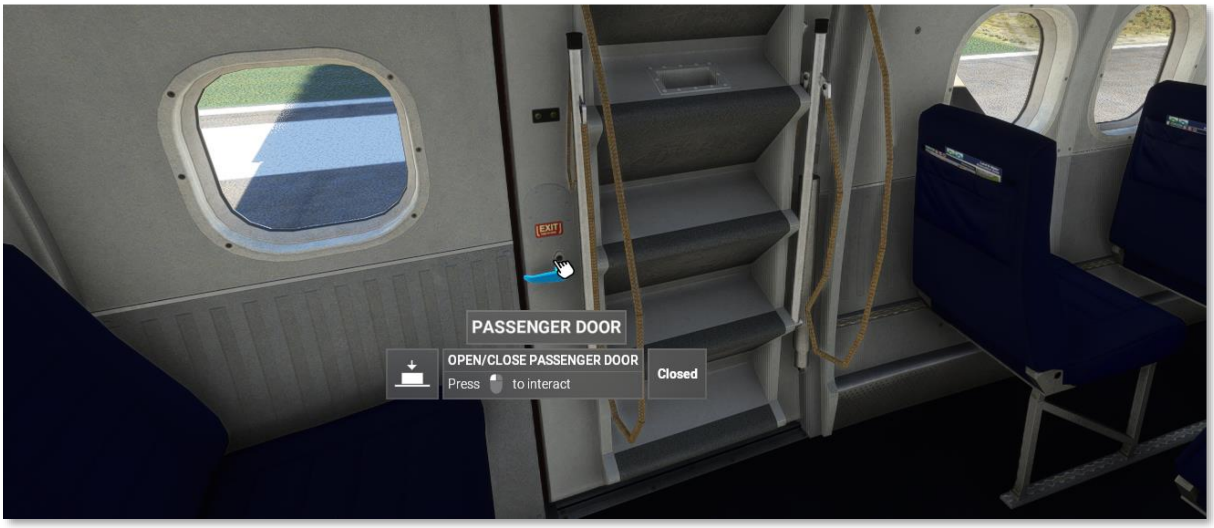
Aircraft that are mainly used for passenger transport are equipped with so-called airstairs. These are passenger stairs that are directly connected to the aircraft. This eliminates the need for a mobile access stairway.



Airstair DHC-6-400

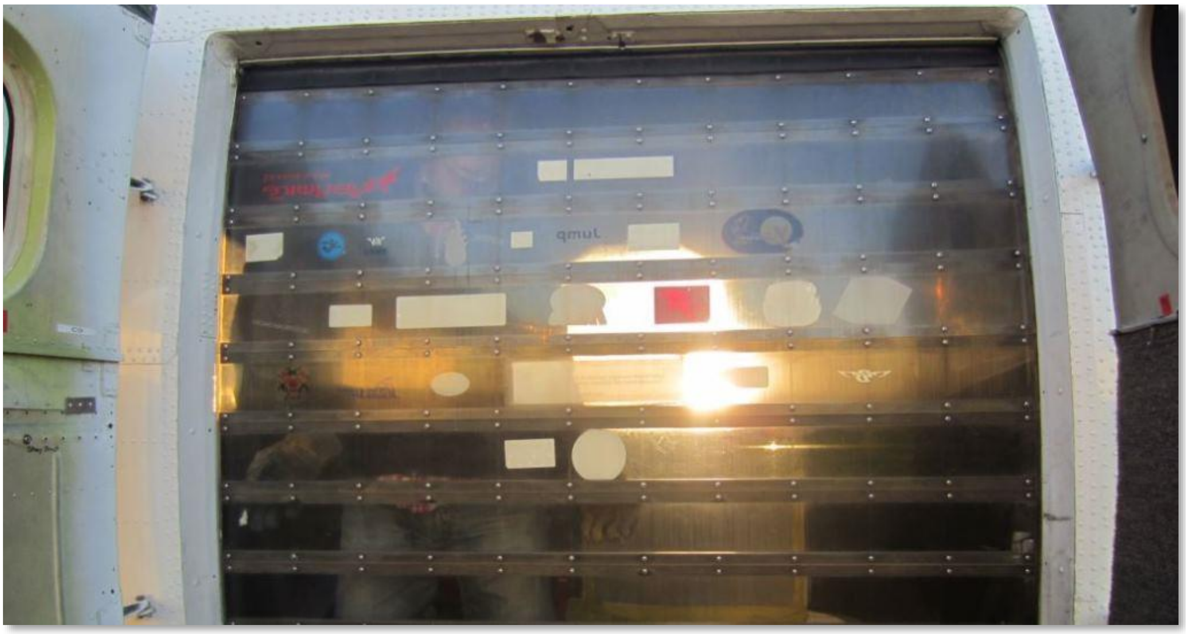
It is important not to overload the Airstair, and only a maximum of one person should climb the stairs. It has happened in Oceania that on a scheduled flight in the Torres Strait (Australia), a passenger who weighed much more than the standard adult weight of 85 kg bent the stairs. This had the consequence that the door could be closed only with difficulty, and the aircraft had to be taken out of operation to be repaired

To open the airstair doors, click on the handle.



SKYDIVER DOOR

For skydiving operations, the normal doors are removed and are usually replaced by a transparent plastic roll-up door. In certain conditions, the door opening is left as it is.



Skydiver door

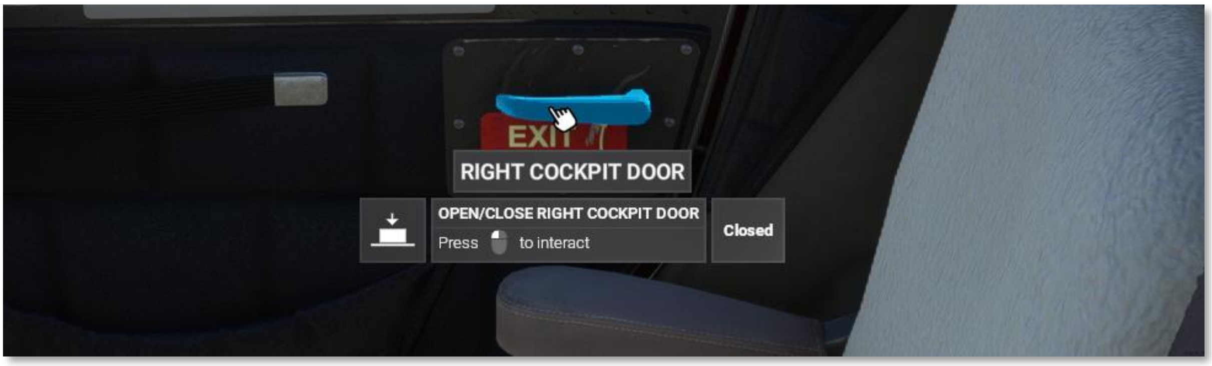
To open the skydiver door, click on the bottom.

HATCHES

There are two switches on the lower centre console to open the nose cargo door and the main fuselage cargo doors.

COCKPIT DOORS AND OTHER FLIGHT DECK ANIMATIONS

Opening the cockpit doors is done by clicking the door handles.



You can move the armrest:

To have better access to the instruments, it is possible to remove the yoke by clicking on the base:

Clicking on the small door on the cockpit floor will let you toggle the gust lock. The extended sound is what you hear when you stow the lever.

The small button on the utility lights will toggle the white and red light mode:

SYSTEMS DESIGN AND FUNCTIONS

The DHC-6 does not always follow the current aviation standards regarding design and switch or instrument arrangements. Therefore, some terms and explanations will be duplicated, but in our eyes, this is important for understanding the systems and explaining the panels.

In addition to the engines and the propeller, we also describe the oil and fuel system and explain the electrical system, among other things. We only go into as much depth as is necessary to illustrate the DHC-6 design for all points.

ENGINE

The Twin Otter is powered by a Pratt & Whitney PT6-A turbine. This is one of the most famous aircraft engines, with its design done in the early 1960s. It has been used in every vehicle, from hovercrafts to ships. These turbines are true lightweights, and the shaft on which the propeller is mounted has no direct connection to the engine. It is only aerodynamically coupled, so the compressor and power turbines are not mechanically connected.

The PT6-A engine is extremely reliable with an in-flight shutdown rate of 1 per 650 thousand plus hours, and therefore it is also the perfect partner for the workhorse Twin Otter. However, one should always watch the operating temperatures, especially operation in the so-called Beta Range that must be avoided over a long time.

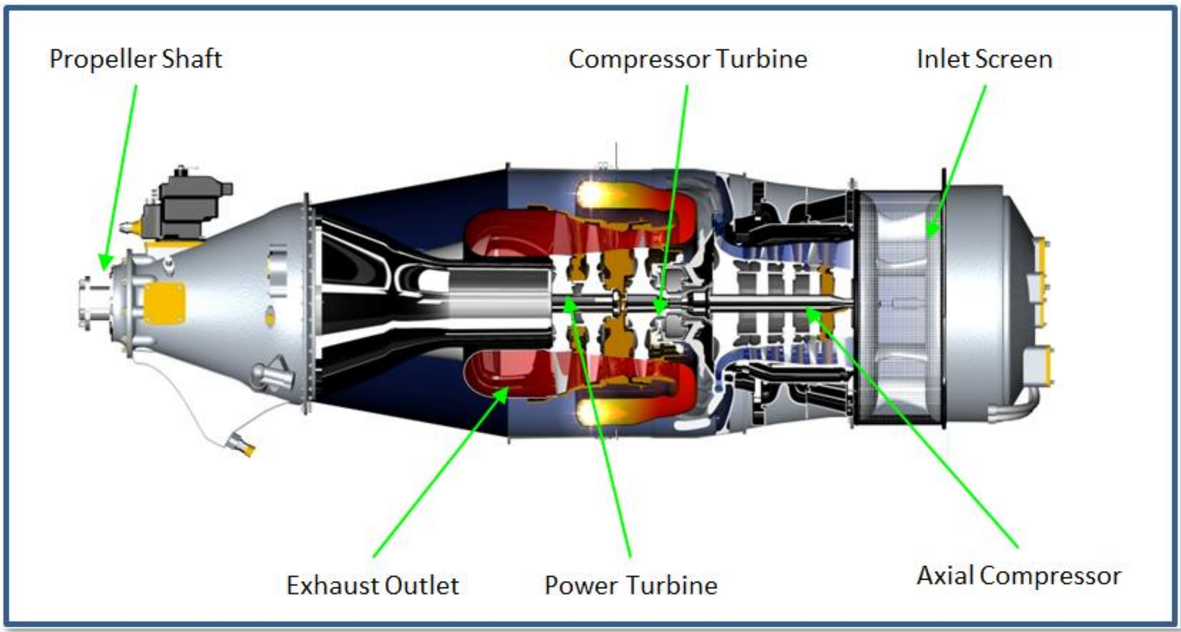
We will only briefly describe the engines here, as there are plenty of sources on the Internet that explain the principle of the turboprop engine in detail.

PT6-A TURBINE

The PT6 has been extraordinarily successful in commercial terms. Since large-scale production in 1964, over 50,000 PT6 engines have been manufactured in 88 versions (65 of them PT6-A). The low-power turboprop versions are designated A-11 to A-36 and A-110 to A-135, the medium-power versions A-40 to A-45R, and the high-power versions A-60 to A-68.

The first segment (stage) operates the gas generator, while the second turbine drives the propeller. Since quite high speeds of about 33,000 rpm are reached here, the propeller speed is driven by a reduction gear.

It certainly sounds strange, but the turbine is designed so that the air moves over the engine, cowling and then, in the case of the PT6-A, enters the engine from the rear. The air changes direction three times in the turbine before leaving the engine through the exhaust.



The PT6A free-turbine engine, i.e., a turboprop without a continuous shaft, functions practically like a jet engine. Air is compressed in various compressor stages before it enters the combustion chamber. There it is mixed with fuel and ignited. The air expands due to the large temperature increase and drives the power turbine. The turbine is connected to the engine's compressor section, which drives it. The aerodynamic connection with another turbine makes it possible to drive the propeller via a reduction gear. However, since they are not mechanically connected, it is also referred to as a free turbine.

As described, the inlet is at the rear of the PT6-A, and the exhaust is at the front. This puts the turbine driving the propeller closer to the gearbox and the propeller. Below the engine sits the large air intake, an inertial separator, a large deflector that can be extended to prevent dust, dirt, or ice from being sucked in. The inertial separator is pneumatically extended and electrically locked. It can be activated from the cockpit via a switch on the panel. Pilots will find the control indicator in the form of the Doll's Eyes on the panel.

The inertial separator is a fine wire mesh moved into the airflow. The air now describes a flatter path, and because of the particles' inertia (dirt, ice, etc.), they can't be sucked into the engine. However, the engines' full load (max torque) cannot be expected due to the reduced airflow.

The engine's bleed air is used to operate the heater and inflate the leading edges of the wings in icing situations.

One of the strengths of the Pratt and Whitney PT-6 engines is reliability, as explained to us by Simon Blakesley. He spent a summer in the Canadian Arctic as an aviation engineer for the RCAF. The crew was based at Eureka, a remote weather station on Ellesmere Island. Back in the days before satellite communications and GPS systems, the crew would have had a serious problem if they had to make an emergency landing in their CC-138 Twin Otter somewhere on Ellesmere Island, the tenth-largest island on Earth.

In all the months of flying, Simon had had unexpected trouble with the engine only once but before a flight to Thule in Greenland. He checked the engine and found a defective torque pressure transmitter. Fortunately, this could be replaced, and the flight was made.

Simon was very enthusiastic about the deflector flaps installed in each engine and praised their advantage as a mechanic. The flaps were lowered before landing or running away with loose surfaces. Almost like shutters, they prevented rocks or small gravel chips from being thrown into the engine and damaging it. Although the use of the deflectors results in a small loss of power, one is happy to accept this if, like Simon, one is flying the Twin Otter in the Arctic, almost cut off from the outside world.

ENGINE STRUCTURE

Most turboprop engines have a gearbox that drives the propeller. This is coupled directly to the main shaft of the engine. When the engine is started, the battery must provide enough power to turn the compressor, turbine, gearbox, and propeller. This often requires large and powerful batteries. The inertia of the propeller and all the rotating parts, especially in cold weather, means a lot of power is required from the battery. In addition, quite high starting temperatures are usually the consequence.

With the PT6 turbine, however, this is different. The free turbine only drives the gearbox and the propeller. The gas generator is aerodynamically coupled. So the battery only has to start the compressor and the compressor turbine. Conversely, this means much less acceleration, less load on the engine, and colder starting temperatures.

The reverse flow design allows the PT6 turbine to be serviced more easily and practically. This means that the power turbine can be detached separately from the rest without completely disassembling the engine. The gas generator remains on the wing, the starter, alternator, hydraulic pump, and FCU. This greatly simplifies maintenance, hot section inspection (inspection of the combustion chamber), an overhaul of the gearbox. If, for example, there is a bird strike on the propeller, the repair can be done separately.

The only section in which the airflow is normal or passes through from front to back is the combustion chamber. This design has also reduced the overall length of the engine. The hot gases leave the combustion chamber, and the flow direction is reversed before entering the turbine. The centrifugal turbine stratifies the air masses so that the temperature of colder air is created at the turbine wheel root, and hotter air is created at the blade tips of the turbine. These are precisely the effects that are also desired on the turboprop, as they result in maximum efficiency and turbine longevity.

ENGINE MANAGEMENT

Under normal ISA conditions (+15°C), PT6 engines tend to have torque limitations below 16,000 feet. Above the altitude just mentioned, more attention must be paid to the T5 indication. Simmers should never use maximum torque for extended periods.

For the PT6-27 engine, configurations should be at a maximum of 50 PSI (42 PSI for the PT6-20) in ISA conditions (+15°C) and takeoff at Sea Level. After that, reduce at about 0.63 PSI per 1,000 feet until you get to an altitude of 16,000, at which point pilots reduce at 1.00 PSI while, of course, monitoring the T5 temperature. But just like in a car, it makes no sense to push the engine to the power limit for no reason; it makes more sense to use a more conservative torque setting.

As described, the propeller levers should be pushed fully forward for takeoff and then pulled back to 91% during a climb. We recommend setting the Twin Otter's propeller levers to 75% in cruise flight.

Although we have included the performance tables of the real DHC-6 at the end of this book, due to the limitations of the Aerosoft Twin Otter, some of the non-linear metrics of the actual engines have been simplified into somewhat moderate linear curves. This means that the real tables should be used more as a rough guide.

As you can easily see, the Aerosoft Twin Otter has realistic engine displays for torque, RPM, and ITT. Furthermore, the inertial separator in the engine influences the engine parameters, just like in the prototype.

PROPELLER

The Twin Otter is supplied with either a 3-blade or 4-blade propeller, with approximately the same performance. The 4-blade propeller has the advantage of being much quieter. The propeller turns at a constant speed, which means that the angle of the propeller is set at a certain pitch to maintain a preselected RPM.

Normally, the engines go to the feathered position when shut down after a flight. On some Twin Otters on floats, so-called start locks have been installed. These prevent the propellers from entering the feathered position after engine shutdown due to oil pressure. This has the advantage that no forward momentum is generated by the propeller running up, and the seaplane may move uncontrolled on the water during the engine start.

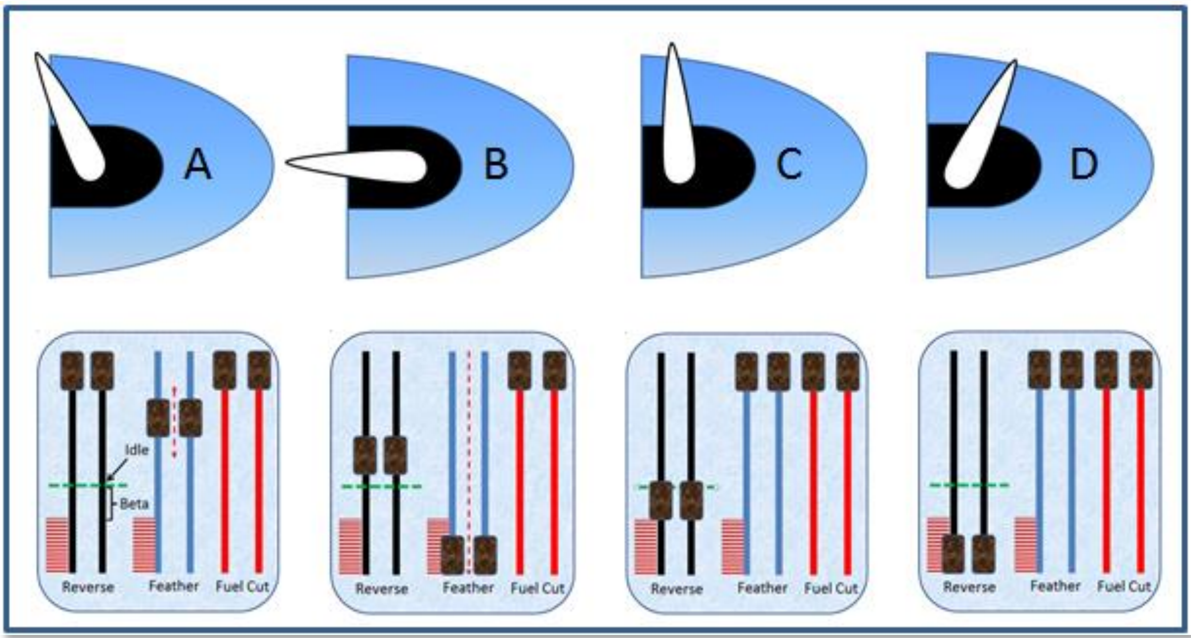
The Twin Otter has an Auto Feather system that automatically moves the propellers into the feathered position if an engine fails. The system detects when there is too great a difference in torque between the engines.

Behind the flight idle, the beta range begins. In this range, you can directly influence the angle of attack of the propeller blades with the help of the power levers. You enter the reverse thrust range if you pull the power levers further back.

Before the day's first flight, certain Auto Feather System and Beta Range System functions should be checked. Testing the Beta Control System includes the Beta Range System. This prevents the propeller from moving into an unacceptable blade position should the Beta Control System malfunction. A small microswitch detects when the reverse thrust is used in test mode.

The constant-speed propellers have a mechanism that can change the blade angle between 17° degrees and -15° degrees (Beta range). In addition, through the Prop Overspeed Governor, the propeller is protected against overspeeding. The rotation speed is displayed on the propeller tachometer on the instrument panel as Np.

PROPELLER CONTROLS



Propeller Pitch Angle

The image above shows how the control levers control the propellor settings. The Fuel levers (right) do not ‘control’ fuel flow; they are just cut-off switches. On/Off.

A. Normal use. You use the power levers (left) to control the engine and the propeller levers (middle) to control the propeller's pitch. Pushed forwards, the blades have a small pitch angle, and you get high revolutions; pushed backwards, the pitch increases, and the RPM will be lower. Following the tables, you can set the best performance/fuel efficiency.
B. The feathered position (B) has the highest angle of attack. In this position, no propulsion is produced. In-flight, the propeller is never found in this position unless the engine had to be shut down due to a problem. To avoid drag, the propeller is then pulled into the feathered position.
C. Flat pitch (C) is the flattest setting of the propeller, where there is the least resistance to rotation and no forward thrust. In this setting, the propellers form a ‘flat disk’ that will provide additional drag. This is useful to slow down or to a steeper descend.
D. In reverse pitch, the propeller will actually provide reverse thrust. This is mainly used for slowing down on the ground during the landing but can also be used to taxi backwards. This should be done with great care, though, as debris can be sucked into the engine. Use in flight is not permitted.

On a turboprop engine, the power levers range between flight idle and MAX (maximum power) during flight. The power lever directly controls the fuel control unit regulating the fuel supply to the engine.

The Propeller Governor controls the blade angle of the propeller to stay within the selected RPM set by the prop lever. This is also called the Governing Mode or Alpha Mode.

In summary, the DHC-6 uses the prop lever to set the RPM, which is displayed as a percentage on the instrument panel. The propeller speed is controlled by the angle of attack of the propeller blades, which means that a large speed brings a smaller angle of attack. The propeller does not turn faster when the power levers are pushed forward, hence the name constant-speed propeller, but it simply increases the pitch of the propeller blades relative to the incoming air. Thus, both the power levers and the prop levers affect propeller performance.

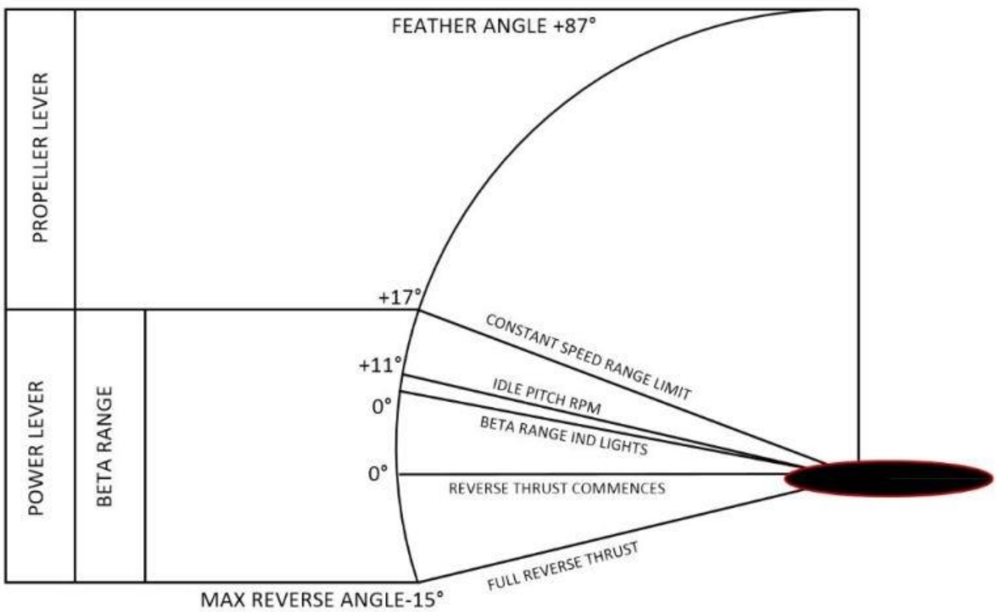
PROPELLER RANGE

In normal operation, the propellers run in the so-called constant-speed range. The angle of the blade here is +17 degrees to +87 degrees; in this range are the phases of climb, cruise, and descent. So until the flaps are set, the propeller levers are still in the cruise position.

After the Twin Otter has decelerated to flap speed, the Prop Levers can be set forward to MAX RPM to make full power available for a possible takeoff manoeuvre.

After landing gear touchdown, reverse thrust is immediately available. Here the Beta valve is activated, and the pilot can directly control the blade pitch angle via the Power Lever. The angle of the propeller in this range here is from +17 degrees to -15 degrees.

Idle Pitch is the range in which the propeller produces no thrust, i.e. is idle.



The above graph describes the position of the propeller blade. In the constant-speed range, i.e. the normal speed range, the blade is set at +17 degrees to +87 degrees.

In the Beta Range, on the other hand, the blade is set at +17 to -15 degrees, which includes the range of reverse thrust. The Beta Range will be discussed in more detail in the following sections.

PROPELLER BETA RANGE

The Beta Valve, located on the gearbox housing, controls the blade angle when the propeller approaches the 0-degree position. At this point, the Beta Valve lights on the cockpit panel will light up in blue. We are now in the area where the Prop Governor is turned off, the Beta Valve is activated, and the pilot has direct control over the position of the propeller blades with the power lever.

The power levers can be used to move the blades up to -15 degrees into reverse range (reverse thrust), allow for reverse taxiing, and minimize wear and tear on the wheel brakes (brake discs and pads).

PROPELLER GOVERNOR

The Propeller Governor is part of the CSU (Constant Speed Unit) and controls the speed of the propeller. For example, a constant speed of 96% Np is set with the prop lever. The governor corrects this by adjusting the blade angle for various performance requirements, such as climbing, descending, or changing the cruising speed.

This can be compared to a gear change on a bicycle. While the cyclist pedals at a constant speed, the speeds on the rear wheel can be varied by changing the gear ratio and selecting different gears.

OIL SYSTEM

Each engine has a built-in oil system consisting of oil tanks, pumps, filters, and cooling radiators. The warm oil is also used to bring the engine fuel up to temperature before it is injected into the engine.

The engine oil is primarily used to lubricate all moving parts in the engine housing. In addition, oil acts as a seal between various components and distributes heat. Oil has a certain cleaning function and needs to be changed regularly, as acid and metal deposits accumulate in the fluid.

LOW OIL PRESSURE CAUTION LIGHT

The Caution Panel has two oil pressure indicators when the pressure drops below 40 PSI. They go out when the oil pressure returns to at least 44 PSI. We will briefly discuss the caution lights again in the Instrument Panel section.

OIL TEMPERATURE AND PRESSURE INDICATORS

The oil pressure indicator should be in the green range about 30 seconds after engine start. If this is not the case, pilots will shut down the engine again for safety reasons to avoid damage.

The oil temperature should also be in the green range. There is an important connection between the temperature and pressure of the oil. If the oil becomes too hot and the temperature rises, the oil pressure will drop in return, as the oil has now become thinner.

FUEL SYSTEM

The Twin Otter has a very reliable fuel system, but because the fuel tanks are located on the underside of the airframe and the engines are mounted above them, so-called booster pumps are required. Therefore, handling these boosters or simply auxiliary pumps is very important and will be explained in this section.

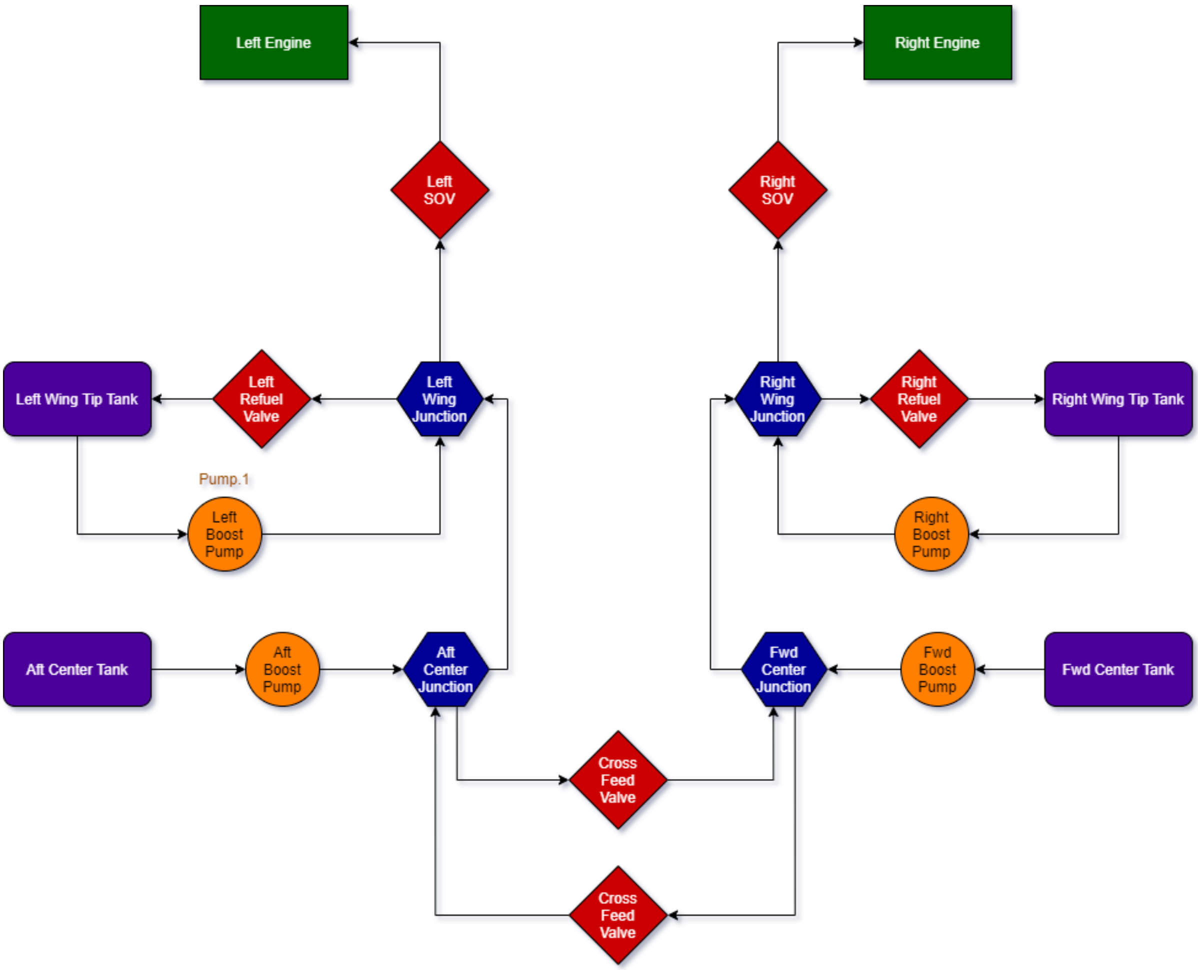
In the picture above, you can see the Fuel Selector Switch, the two Standby Booster Pump Emergency Switches (2), the Booster Pump Switches, and the Fuel Quantity Indicator Test Switch.

FUEL TANKS

The Twin Otter has two fuel tanks. The forward tank and the aft tank are located underneath the cabin, making the booster pumps indispensable. Each tank has two booster pumps located in the collector cells. The pumps operate according to a redundant system; the other steps in if one fails. Keep a close eye on the fuel pumps!

The tank caps are located on the left side of the fuselage. All cells are ventilated to ensure that there is always positive pressure in the tank. Each tank contains four cells. In the forward tank, cell number 4 is the collector cell. The forward tank capacity is 691 litres of fuel. In the aft tank, cell number 5 is the collector cell. The aft tank capacity is 755 litres.

USABLE FUEL		FORWARD TANK			AFT TANK		
Fuel Grade	Density	Weight LB	Imp.Gal	U.S. Gal	Weight LB	Imp.Gal	U.S. Gal
Jet A	8.18	1235.2	151.0	181.2	1341.5	164.0	197.8
Jet A1	8.16	1232.2	151.0	181.2	1338.2	164.0	181.2
Jet B	7.80	1177.8	151.0	181.2	1279.2	164.0	181.2
JP-4	7.80	1177.8	151.0	181.2	1279.2	164.0	181.2
JP-5	8.16	1321.2	151.0	181.2	1338.2	164.0	181.2
JP-8	8.07	1218.6	151.0	181.2	1325.5	164.0	181.2



The fuel system has Booster Pump Switches and also warning lights. As mentioned above, if pump number 1 fails, pump number 2 is immediately activated, and system pressure can be maintained. Failure of both pumps is highly unlikely, but it could result in a flameout if it were to happen. In this situation, the system pressure would not supply the engine.

You can check the function of the low-pressure switch by turning on the boost pumps during the pre-flight check and observing if the two corresponding boost pump low-pressure lights go out.

Normally the front tank supplies the right engine, and the rear tank supplies the left engine, but crossfeed is also possible. This means that one tank can supply both engines. In the event of an engine failure, the good engine can be supplied with fuel from the tank of the failed engine. However, it is impossible to transfer fuel from one tank to another. The crossfeed valve is marked and labelled with a green circle in the drawing below.

The fuel supply is controlled by the red fuel levers in the overhead panel. Only two positions are ON (forward) or OFF (backwards). Each lever is directly connected to the engine's cut-off valve.

A check valve, filter, fuel flow meter, and cut-off valve are part of each engine's supply line. In addition, an automatic purge valve is part of the fuel line. During engine startup, it eliminates any trapped air from the Fuel Control Unit (FCU). The Twin Otter has two fuel gauges in the main panel for the main tanks and, optionally, two gauges for the tip tanks (wing tanks), each displayed in lbs (pounds). Warning lights for low-level indication can each be found on the Caution Light Panel. However, there are dipsticks for the Twin Otter to determine the amount of fuel. To do this, the aircraft must be parked on a flat surface and ideally waited for

12 hours before measuring. This is the only way to ensure accurate measurements, as it takes time for the fuel level to equalize between cells.

In the diagram, you can see the fuel's path through the line. Starting from the collector cells 4 and 5, the fuel is sent through the lines using the boost pumps. The fuel flows directly through the fuel filter, except when the crossfeed system is activated. In addition, the optional wing tanks may be connected at this point. They would supply the engines because the outlet pressure is higher than the system pressure of the normal booster pumps. Behind the fuel filter are the fuel flow indicators, which measure the fuel flow. Next is the Fuel Shut-off Valve on the firewall. Here, the fuel can be shut off instantly in an emergency, for example, in the event of an engine fire. The fuel then flows directly into the combustion chamber of the PT6 turbine.

By the way, the Crossfeed Valve is powered by the right DC bus and protected by the FUEL XFEED fuse on the Main Circuit Breaker Panel. Up to serial number 510, the Fuel Selector Panel of the Twin Otter was installed on the left side of the Instrument Panel. With serial number 511, the Fuel Selector Panel was placed in the centre of the instrument panel below the engine gauges.

Note the current version of the Twin Otter does not have this fuel system fully modelled due to some simulator limitations. We expect these to be solved soon, though, and update the system when that is done.

WING TANKS

Some DHC-6s are equipped with additional wing tanks, especially for scientific flights or observations. These additional tanks at the wingtips, shown only schematically in the image of the upper section, have a capacity of 287 lbs per side and are sufficient for about one hour of flight.

Since the DHC-6 consumes about 600 lbs of fuel per hour, the cockpit crew can calculate the amount needed relatively easily. By the way, the additional tanks are only available as an option in the 300 version.

The test switch for the tanks only affects the FWD/AFT tank gauge. The gauge for the auxiliary tanks cannot be tested in the same way in the software. However, you can left-click on the red warning lights below the respective wing tank gauges. To use fuel from the auxiliary tanks, you just have to turn on the pumps. These are activated by the switches located above the Wing Tank Gauges and labelled ENGINE - OFF -REFUEL.

These switches control the Boost Pumps or the Shut-off Valves, each responsible for the Wing Tanks, and direct the fuel from the FWD/AFT tanks upward to refill the Wing Tanks. This is an easy way to fill the FWD/AFT tanks and pump the fuel up in remote areas. This procedure saves the ladder and long fuel hose to refuel the wing tanks.

FUEL SELECTOR SWITCH

The Fuel Selector Switch allows the pilot to control the fuel supply from the two tanks. In the NORM position, which is the default, the engines are fed kerosene from the forward and aft tanks. The forward tank feeds the right engine, and the aft tank feeds the left engine. By turning the knob, both engines can draw their fuel from the forward tank or both from the aft tank (BOTH ON FORWARD / BOTH ON AFT).

You will find the boost pump switches at the tank selector switch, respectively, described again in the following section. These switches are labelled AFT Boost Pump and FWD Boost Pump. Upon reaching 110 lbs in the AFT tank and 75 lbs in the FWD tank, the pilot is warned by the respective Fuel Low-Level light on the annunciator panel.

BOOST PUMP SWITCHES

Similar to the Fuel Selector Switch explained above, the boost pumps (3) can also be controlled. Normally the switch is in the AFT BOOST/FWD BOOST up position, which means both pumps are active. Setting the switch to the OFF position will turn off the pumps. TEST allows you to check the functionality of the pumps by holding the spring-loaded switch down: the warning light on the annunciator panel will go off. The switch will jump back to the OFF position when released.

Each switch, therefore, supplies two boost pumps per tank. The secondary boost pump will automatically be electrically activated should the primary pump fail. Independently, the secondary boost pumps can also standby Emergency Boost Pumps. The boost pumps are powered from the right and left DC busses and are protected by fuses on the main fuse panel labelled BST PUMP AFT 1, BST PUMP AFT 2, BST PUMP FWD 1, and BST PUMP FWD 2.

BOOST PUMP PRESSURE CAUTION LIGHTS

There is a warning light for each of the four pumps on the annunciator panel to notify the crew of a fuel system malfunction. As soon as the pressure drops below 2 PSI, the defective pump caution light illuminates, as one pressure switch per caution light is located downstream of the boost pump.

The warnings on the Caution Light Panel are marked BOOST PUMP 1 AFT PRESS, BOOST PUMP 2 AFT PRESS, BOOST PUMP 1 FWD PRESS, and BOOST PUMP 2 FWD PRESS. As mentioned above, in the event of a malfunction of the primary pump, the secondary boost pump will start immediately.

STANDBY BOOST PUMP EMERGENCY SWITCHES

In the unlikely event that the backup pumps do not start automatically, they can be activated manually with the Standby Boost Pump Emergency Switches. The switches installed for emergency use are labelled AFT and FWD and are located above the tank selector switch on the right and left, respectively. The switches have a safety mechanism called a lever lock. You have to move the switches over a cam to activate them; they turn on the secondary boost pump regardless of the system or fuel selector switch position.

FUEL EMERGENCY SHUT-OFF SWITCHES

The Fuel Emergency Shut-off Switches can be used to completely and immediately shut off the fuel supply to both engines. These switches are integrated with the fire panel. They are switched on before the Fuel Control Unit and activated if the Fuel Levers cannot be switched off mechanically.

FUEL LOW CAUTION LIGHTS

The Fuel Low Caution Lights illuminate when less than 110 lbs of kerosene are in the aft tank, or 75 lbs of kerosene are in the forward tank. Fuel is detected by sensors inside the tanks. The kerosene in the tanks fluctuates when the aircraft is turning, climbing, or descending. Therefore, the indicator should only be trusted when flying straight and level.

FUEL QUANTITY INDICATORS

As the name implies, the Fuel Quantity Indicators show the current fuel level. The unit is in Imperial or US customary pounds (lbs).

FUEL QUANTITY INDICATOR TEST SWITCH

The test switch, labelled IND TEST, is a push-button. Once the button is pressed, the gauge needles are de-energized and should drop to zero. Once the button is released, the needles should indicate the correct amount of fuel. Moving the fuel gauges confirms that the gauge is powered by 115 volts AC and operational.

FUEL HEATERS

Fuel heaters represent an autonomous system. Heat-sensitive valves protect the fuel from freezing. For this purpose, warm or hot engine oil is taken and fed past the tanks. The combination of waste heat and the sensitive valve allows the fuel to be kept at an almost constant temperature. Note that depending on the amount of fuel in the tanks and the external temperature, it can take some time to warm up the fuel in arctic conditions.

There are no controls for this system.

Picture by Gaba Sosa

ELECTRICAL SYSTEM

Like an alternator in a car, the starter generator supplies 28V DC. Combined with a 40Ah battery, these two units are the heart of the Twin Otter's electrical supply. Two static inverters supply the electrical system with 115V DC and 26V AC. A bus system supplies power to the consumers. We distinguish between the left and right DC bus (direct current), the battery and external power bus, the hot battery bus (always active), and the two AC busbars.

The electrical system includes Starter Generator, DC Master switch, External Power/Battery switch, Bus Tie switch, Generator switches, Generator caution lights, Generator Overheat caution lights, battery, Battery Temperature Monitor, DC Voltmeter & DC Loadmeter, Inverters, and the Caution Light Panel.

Caution should be exercised in an AC power supply failure - a mnemonic is "AC lies, DC dies". This means the AC Instrument (Torque Pressure, Fuel Quantity, Fuel Flow) will remain at the position they indicate during the power failure. The DC instruments, such as Oil Temperature, Oil Low-Pressure Light, or Wing Fuel Left display zero.

The switch shows the load and DC voltage on the left and right generator and the battery voltage total load in the middle position.

HYDRAULIC SYSTEM

The hydraulic system on the Twin Otter controls the flaps, nose wheel control, and brakes. The major components of this system are the electric pump, emergency hand pump, reservoir, damping and brake accumulators, flap and nose wheel actuator, brake valves, and flap control handle. Also included are a filter, relief valve, check valves, and pressure gauges to control the pressure in the lines. The electric pump pressurises the system, and the damping and brake accumulators regulate the supply.

The damping accumulator ensures the operation of the flaps, the nose wheel control, and the brakes. The brake accumulator supplements the brake system and stores pressure in case the pressure from the damping accumulator is not available or in case of total failure of the hydraulic pump. A pressure switch registers the system's pressure and regulates it by supplying pressure to the system or the two accumulators in the event of a pressure drop.

An emergency pump is also installed in the system. It can be used if the electric hydraulic pump fails. It directly controls the flaps and the nose wheel steering (NWS). This backup pump (a serious workout when you need it) is the only ‘control’ of the hydraulic system. It takes up to 80 pumps to get enough pressure to lower the flaps. The brakes have an emergency reservoir used on the first application of the brakes. Do take note it is easily depleted when you modulate the brakes.

The heart of the hydraulic system is the electric motor, reservoir, accumulators, and pressure indicators. They are called the “power package” and are located under the cockpit floor, so you can service them through a service door on the forward part of the fuselage. Expect to hear a lot of the hydraulic pump as it is very close, very loud, and tops up the pressure very often.

PNEUMATIC AND BLEED SYSTEM

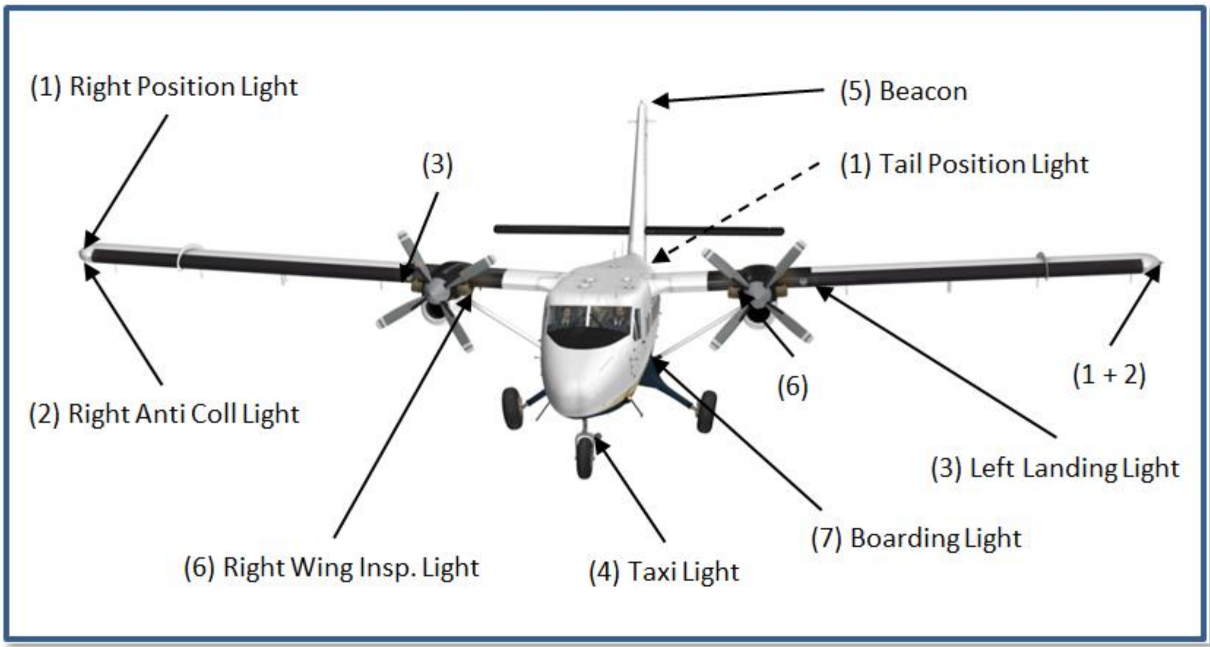
Bleed air is warm air taken from the compressor housing and fed through a line into the interior of the Twin Otter. It is used to heat the interior, operate the de-icing equipment (inflating the leading edges of the wings), and operate the autopilot. It is also used to extend the so-called Intake Deflectors (deflectors in the engine's intake tract).

Bleed air is switched on and off at each engine by the shut-off valve (electric valve). The switch is located in the overhead panel labelled BLEED AIR LEFT and BLEED AIR RIGHT.

On the caution panel, there is a warning light PNEUMATIC LOW PRESS. This lights up when the system pressure drops below 20 PSI. In such a case, hydraulic pressure is insufficient to operate the de-icing equipment and the autopilot.

EXTERNAL LIGHTS

Like every aircraft, the Twin Otter must have a prescribed external marking by lights. For this purpose, there are various individually controllable lights such as the Position Lights, Landing Lights, or Anti-Collision Lights.



Exterior Lights

POSITION LIGHTS

The position lights are located at the wingtips and the aircraft's tail. There are red lights on the left side and green lights on the right. A white light is located at the tail. The position lights indicate the dimensions of the aircraft to other aviation participants. In addition, the aircraft's direction can be determined by the colours. The lights are turned on or off with the POSN LIGHT SWITCH.

ANTI-COLLISION AND STROBE LIGHTS

The Anti-Collision Lights consist of white strobe lights on the wingtips and a rotating red light on the tail of the Twin Otter. The Anti-Collision Lights are switched on with the ANTI COLL LIGHT SWITCH before the engines are started. The strobe light is very bright and flashy, providing good visibility in adverse weather conditions such as rain, fog. The anti-collision and strobe lights are separate and can be switched separately on some versions.

LANDING LIGHTS

Landing lights are activated with the LANDING LIGHT SWITCH located on the starter panel above the Twin Otter's windshield. These should at least be on during approach and departure in VFR flight. If flying under Instrument Flight Rules (IFR), the landing lights must remain on until flight level 100.

TAXI LIGHT

When taxiing at night, the taxi light is switched on. It rotates with the nose wheel, allowing safe taxiing in the dark. The taxi light is activated on the overhead panel.

WING INSPECTION LIGHT

The Wing Inspection Light detects the wing leading edge at night. Especially in icing situations, it is important to check the functionality of the deicing equipment, in this case, the boots of the wing leading edge. The wing inspection lights are each located outside the engine cowling. The switch is located in the overhead panel and is protected by a WING INSP LT DC fuse.

ENTRANCE AND BOARDING LIGHT

The entrance light consists of a door sill spotlight recessed into the Airstair door frame of the Twin Otter on the cabin roof. In addition, there is another cabin door spotlight on the fuselage that illuminates the door area from the outside.

Both lights are protected by the same fuse in the circuit, and the control on the overhead console can be operated by one or two switches, depending on the model. Generally, however, they are marked BOARDING LIGHT and ENTRANCE on the overhead panel

INTERIOR LIGHTS

The interior lighting system of the 300 series consists of six cabin lights, two cockpit spotlights (also known as Utility lights), one ceiling light located in the cockpit, and usually twenty reading lights in the passenger cabin. Panel lights will be discussed in a later chapter.

There are also various lights for the front and rear baggage compartments and, of course, the cabin signs. In the cabin ceiling, passengers will then find the emergency lights. Lighting systems are often adapted and often look very different from one aircraft. The labels on the light controls on the overhead panel should be clear enough.

THE DHC-6 COCKPIT

The Twin Otter is not always equipped with a standard cockpit, and in fact, often has various configurations depending on its use and area of operation. We describe the pilot's workstation using the D-IVER, also included in the product.

COCKPIT LAYOUT

The DHC-6 has an atypical layout. The pilot cockpit extends from the forward bulkhead to the cabin bulkhead and consists of a conventional longitudinal bulkhead frame. Two forward-opening pilot doors are mounted on the right and left sides, respectively, for external access, suggesting that the DHC-6 was designed for two pilots, unlike other aircraft in its class. The cockpit can also be accessed through the passenger cabin.

Many Twin Otter pilots love the more upright seating in the DHC-6; however, our aircraft is more cargo donkey. Thus, the comfort is somewhat reduced, and the cockpit crew has to do without air conditioning and various other amenities. Due to the PT6A engine and the lack of noise protection, it is also quite loud in the entire Twin Otter - as a countermeasure, for example, the TMA in the Maldives distributes earplugs to the passengers.

FLIGHT CONTROL

The Twin Otter is equipped with a conventional flight control system controlled by cables, pulleys, and mechanical connections.

The controls in the cockpit form the letter “Y”. To trim the control surfaces, you will still find the elevator trim wheel, which is located to the right of the left seat. Also located there is the rocker switch for aileron trim and the wheel for rudder trim.

The rudder pedals can be found in the usual place below the control horn on the floor. In the following chapters, different functions of the rudder pedals are described in more detail.

NOSE WHEEL STEERING LEVER

The nose wheel steering lever, or tiller, is found on the left side of the control horn on the captain's side. If you move the lever up, the Twin Otter rolls to the right; the aircraft steers to the left if you move it down. The nose wheel steering can be operated with an angle of 60 degrees to the right and 60 degrees to the left from the centre position. Nose Wheel Steering (NWS) is designed for slow manoeuvres on the apron and is operated by a hydraulic actuator (transducer) mounted on the nose wheel suspension. Incidentally, the NWS lever is mounted in all Twin Otters, as each DHC-6 can be converted to various configurations. So the tiller can also be found in the Float and Amphibious version, but it is secured in the middle position.

When landing, make sure to bring the NWS to the centre position. A skewed touchdown of the nosewheel can result in structural damage; in the worst case, the nosewheel can break off.

In the software, the NWS is animated but is also controlled by the rudder pedals during slow manoeuvres. Very realistically implemented, the Tiller moves up to a speed of 20 knots, then the rudder engages, and the NWS lever returns to the centre position.

RUDDER PEDALS

The rudder pedals are mounted for both the pilot and co-pilot. Each pair of pedals can be moved forward and aft to allow the cockpit crew to control them more comfortably. If you have external pedals, which we highly recommend, you know how to position them. When using external pedals with Microsoft Flight Simulator, ensure that Assistance Options > Piloting > Auto-Rudder is OFF.

Rudder pedals have a dual function, controlling the rudder by pushing the pedal and braking using the toe brakes. The brakes can be controlled individually and independently from both seats, called “differential braking”.

Using the rudders, the pilot can control the aircraft from a speed of about 20 KIAS during the takeoff procedure. Before that, the Twin Otter is controlled by the Nosewheel Steering System on the ground, which, incidentally, has no direct connection to the rudder pedals. The pedals control the vertical axis once the Twin Otter is in the air (yaw).

The crabbed approach is also exciting, i.e. the landing method in which the Twin Otter turns the aircraft's nose into the wind using the rudders. It then becomes challenging shortly before landing, when the DHC-6 is turned just before the touchdown point on the centreline, and the aileron is used to point the windward wing slightly downward so that the wind does not get under the wing. For example, such methods can be practised very nicely at the Siletz Bay (S45) airfield in North America.

However, real and virtual pilots should not use the brakes when rolling back because otherwise, the Twin Otter is likely to tip backwards, possibly damaging the tail. We advise keeping your feet on the ground rather than in the rudder pedals to prevent unintended braking.

GUST LOCK

The control lock, also called Gust Lock, is used to secure the ailerons, rudders, and elevators when the Twin Otter is parked. This lock ensures that control surfaces are not pushed against their stops, for example, in strong gusts of wind.

The design keeps the control column in a fixed position, protecting ailerons and elevators. The rudder is locked in place by a mechanism in the floor, activated by attaching the Gust Lock with push pins to the floor.

The rudder lock can be removed by clicking on the Gust Lock floor opening in the simulated world. This will also trigger an extended sound effect that includes the device's storage.

BRAKING SYSTEM

The main landing gear wheels are equipped with disc brakes that can be operated by the rudder pedals of the pilot and co-pilot. The brakes are controlled by hydraulic pressure: the harder the pedals are pressed, the harder they apply. However, the Twin Otter does not have an anti-lock braking system (ABS).

> *Simnote:*
> *Releasing the parking brake is normally done by pressing the toe brakes (the top of the rudder pedals). The Twin Otter supports this; however, it doesn't work with all configurations, so it has been disabled by default. It needs to be activated in the .flt files you use to enable it. There are multiple ones in each Twin Otter subfolder:*
>
> *Approach.flt*
> *Apron.flt - Cold&Dark when the aircraft is loaded at a parking position or gate*
> *Climb.flt*
> *Cruise.flt*
> *Final.flt*
> *FinalWater.flt (Float versions only)*
> *Hangar.flt - Hangar only. Not used during active flying*
> *Runway.flt - Engines running when the aircraft is loaded on a runway*
> *RunwayWater.flt (Float versions only)*
> *Taxi.flt - Engines running when the aircraft is loaded on a taxiway*
>
> *Open any of these in a text editor and find the text "DHC6_RELEASE_PARK_BRK_BY_TOE_BRAKES", and change it to DHC6_RELEASE_PARK_BRK_BY_TOE_BRAKES=1 if you want to activate the features. Change it back to DHC6_RELEASE_PARK_BRK_BY_TOE_BRAKES=0 to deactivate it if you encounter issues. Save the file and start a new flight. You need to repeat these steps for each .flt file in each Twin Otter variant. You can copy them from one variant to the others, though.*

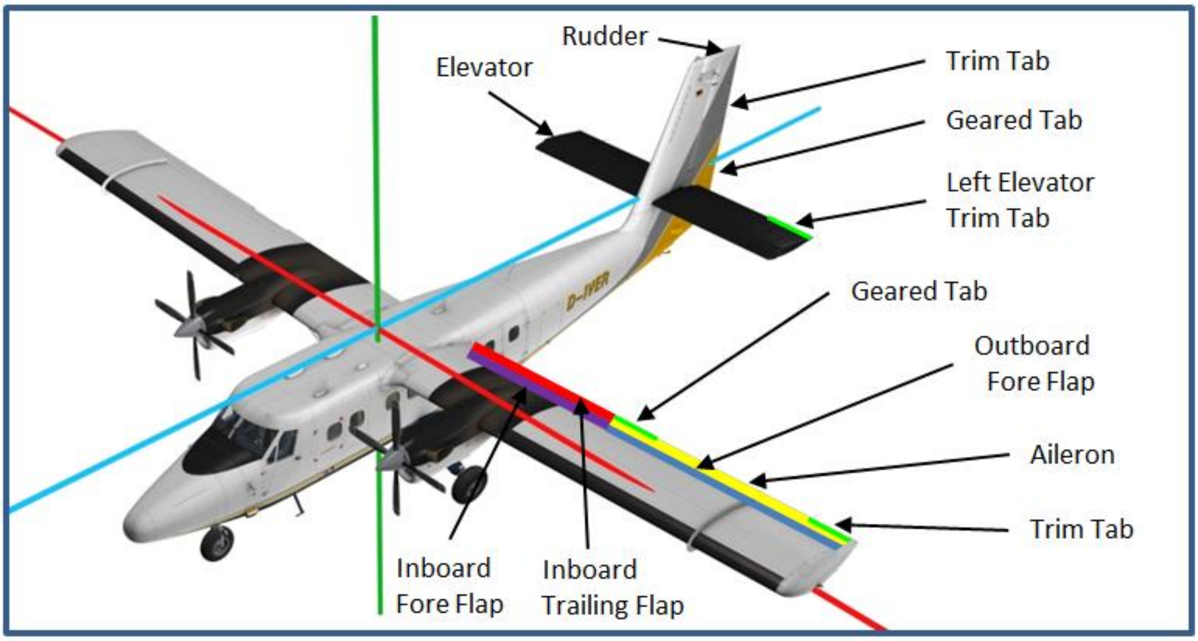
PARKING BRAKES

The parking brake is used for parking the aircraft and is similar to the handbrake in a car. The parking brake is also hydraulically operated and can be set by a small handle in the spar between the pilot's rudder pedals. However, this is not an active brake to stop a taxiing aircraft but a passive brake to hold a stationary aircraft in position. Since there is not as much pressure on the brakes when the parking brake is activated as when the pedals are fully depressed, so-called chocks (brake pads) should always be used on the wheels of the Twin Otter, especially if it is not a level surface

Generally, the brake is set by depressing the pedals and pulling the brake handle on the spar between the pilot pedals. The brake can be released by tapping the toe brakes or pushing the handle forward. You do not have to press the toe brakes in the simulator but can just click the red lever to toggle the parking brakes.

FLIGHT CONTROLS

The controls of the Twin Otter do not differ from those of other aircraft. Nevertheless, we would like to briefly introduce the individual control elements.



All flight controls on the pilot and co-pilot side, i.e. rudder pedals, the control wheel (or yoke), and, obviously, the Y-shaped control column, are linked and move in sync.

AILERON

The ailerons are operated using the control wheels. A cable system with Bowden cables and pulleys runs through the front of the fuselage into the Twin Otter's wings, controlling the ailerons, which move in opposite directions. This means that when the left aileron moves up, the right aileron moves down. A spring system is installed to keep the cables under tension and prevent them from slipping off the pulleys.

The Twin Otter's aileron has some special features. For example, only the left aileron has a trim tab, but an auxiliary tab is found on both sides of the wing. The ailerons are connected to the outboard fore flaps and extend together. This action can be seen very nicely in the simulator.

RUDDER

The rudder is controlled by the rudder pedals in the cockpit. A cable system runs from the cockpit to the tail unit and moves the rudder. The rudder provides control about the vertical axis, also known as yaw. When the right pedal is depressed, the rudder swings to the right, and the Twin Otter steers to the right as well. The rudder has both a trim tab and a small geared tab that counteracts the forces needed to move the rudder.

In cruise flight, the rudder pedals are not used. However, there are situations where the cockpit crew must use the pedals. For example, in the event of an engine failure, the pedal must be gently depressed (“*Step on the good engine*!”) until the yaw moments are rebalanced, and the Twin Otter is re-trimmed.

ELEVATOR

The elevator is operated by pushing or pulling the control wheels and thus moving the control column. An elaborate cable pulley system controls the Twin Otter's tail elevator. It works as follows: If you pull back on the control wheel, the elevator moves up; the elevator surface moves down if you push the control wheel. In addition, small counterweights have been mounted on the control surfaces to reduce flutter.

The left rudder surface has a trim tab, with which the elevator can be optimally balanced in the cruise phase. This is mechanically controlled by the trim wheel.

FLAPS

The flaps of the Twin Otter are three hydraulically operated surfaces on each wing. The outer flaps are called outboard fore flaps, and they extend up to 12 degrees. The ailerons are attached to the outboard fore flaps and move with them, providing improved roll authority with flaps extended. The engine's inner flaps are the inboard fore flaps and the inboard trailing flaps. Their combined range is 37.5 degrees, just shy of the 40 degrees promised in the cockpit.

Since the flaps extend and retract at a fairly leisurely pace, and the placement of the flap lever in the overhead panel makes it hard to glance at its position, the Twin Otter has a flap indicator integrated into the centre column dividing the windshield. This makes it easy to check the actual flap position without taking the eyes of the runway ahead. The flaps are mechanically linked to the trim system to mitigate the flaps' effect on the aircraft's pitch. Extending the flaps causes some nose-up trim to counteract the upward pitching motion of the aeroplane; retracting the flaps results in some nose-down trim.

TRIM SYSTEM

The DHC 6 Twin Otter has a three-axis trim system electrically and manually operated. Since the trim panel is located to the right of the pilot's seat, it is rather difficult for the co-pilot to operate this element.

Trim allows the pilot to keep the aircraft in a specific attitude without actively controlling inputs. Thus, when climbing, the yoke does not have to be pulled back permanently but can be left in a comfortable or even neutral position by the trim. The three-axis trim system allows the elevator, aileron, and rudder trim.

Normally, another button is behind the Aileron Trim switch to illuminate the trim panel. In our virtual Twin Otter, the lighting of the trim section is controlled using the knob labelled “CONSOLE FLAPS & TRIM PNL LTS”.

YAW DAMPER AND AUTOPILOT CONTROL WHEEL

The Yaw Damper is a system that prevents the aircraft from yawing. Yaw is used to describing movement about an aircraft's vertical axis. A yaw damper uses a gyroscope to measure the angular velocity (yaw rate). The very small deflections execute an automatic rudder movement from the measured value.

The button in the Twin Otter is functional and is located on the control column. It prevents, for example, turning around the vertical axis by countersteering with the rudder, as described above. The Yaw Damper must be turned off during takeoff and during landing.

The pilot must manually trim out the Twin Otter before activating the yaw damper. An optimally trimmed aircraft can be recognized because the ball in the vial of the yaw indicator is in the centre. The yaw damper knob is located on the Y-shaped control column next to the autopilot control wheel.

Next to the Yaw Damper, the control wheel is the knob that controls pitch up and down, and banking left and right in autopilot mode. The control horn should move accordingly; if the pilot turns the Turn Knob to the left, the control horn will move to the left; if he turns the knob to the right, the control horn will also move to the right.

Moving the Pitch wheel DOWN will tilt the control horn forward and the nose of the Twin Otter down. If you turn the pitch wheel to UP, the control horn is pulled backwards, and the plane's nose is moved upwards.

OVERHEAD PANEL

The overhead panel is the control centre of an aircraft and replaces many controls that were formerly located on the flight engineer's panel. On the Twin Otter, controls, switches, and fuses are also located above the pilots' heads and can be operated from either seat. Not without some serious stretching, though.

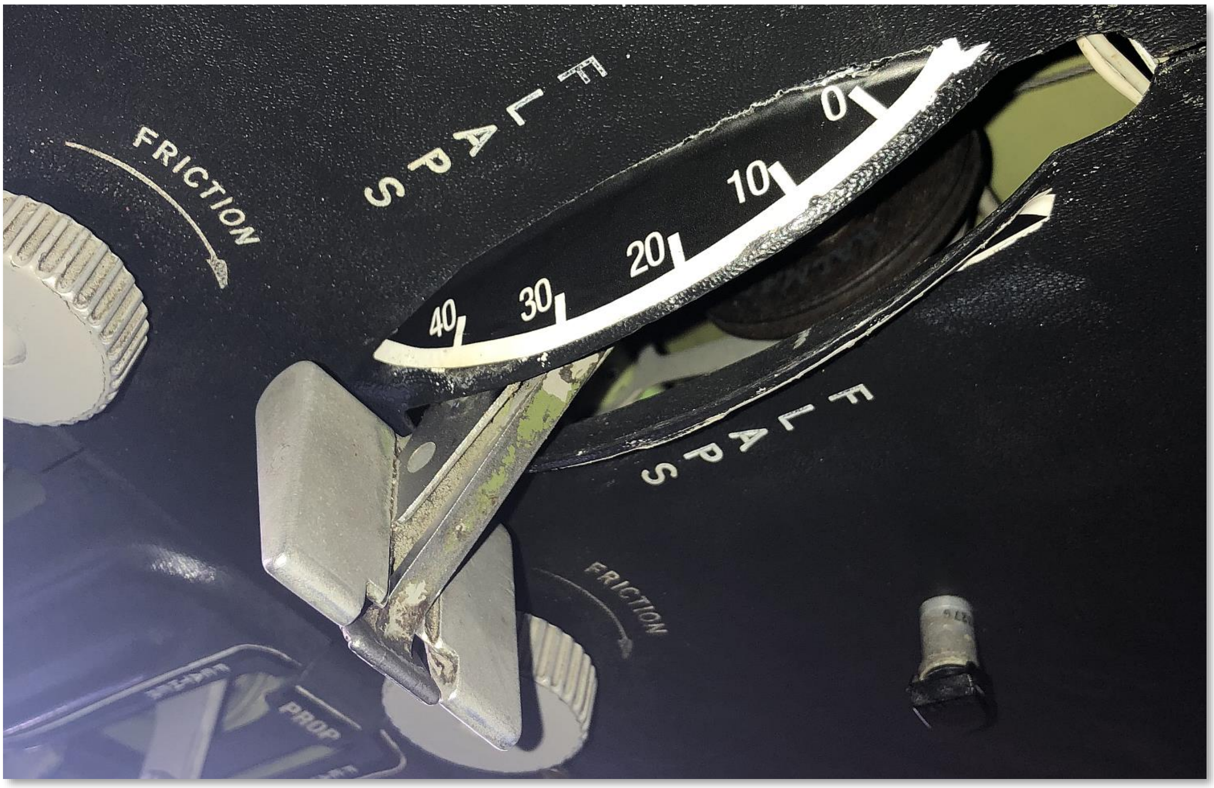
Next to the overhead panel, above the pilot’s head, placards provide essential information about, for example, V-speeds and generator limits.

ENGINE CONTROLS

The engine controls are also part of the overhead panel, but they are described in more detail in an upcoming section for a better understanding.

FLAP HANDLE

The flap handle lever is used to set the flap position. The flaps are hydraulically operated and can be extended to 37.5° degrees in the Twin Otter. The pilot must first press a safety release in the aircraft before setting a new flap position and then moving the lever forward or backwards.



Incidentally, the flap indicator is located exactly in the centre strut of the cockpit window. Hence, pilots are always aware of the flap position and do not have to orient themselves by looking up at the flap lever. The maximum flap extension is marked on display as 40 degrees, but in reality - as mentioned before - it is only 37.5 degrees.

START PANEL

The starter panel is the heart of the cockpit; without it, the Twin Otter would sit cold & dark on the apron.

The DC MASTER SWITCH toggles between OFF and DC MASTER positions and controls power to buses except for the Main Battery Bus, in conjunction with the EXTERNAL/BATTERY Switch and the BUS TIE Switch. In the OFF position, no power is transported to the power bus bars regardless of the EXTERNAL/BATTERY switch position. In the DC MASTER position, current from an external power source or the battery is routed to the left and right buses depending on the EXTERNAL or BATTERY switch selection. If the Bus Tie switch is not in the NORMAL position but in the OPEN position, the current will be routed from the left generator to the left bus and from the right generator to the right bus. It should be mentioned here that the left bus feeds the battery, but the right one is only in the NORMAL position. The DC Master Switch can be moved with a right or left click as the other switches.

The STARTER SELECT SWITCH has three different positions marked START on the panel. This switch is in the OFF function in the centre position but can be pushed to the left or right to start. Electrical power is supplied to the relevant starter generator when the switch is pressed to the LEFT or RIGHT position. The START switch also automatically arms the ignition system and opens the fuel valve for the relevant engine. Once the START switch is released, the starter system is disabled or without power. The engine would then run down again unless the self-sustaining speed was reached. The switch does not have to be held down in the simulation but can simply be clicked to the left or right with the mouse. This has, of course, the advantage that one can devote oneself again to the checklist during the start procedure.

The landing lights have also been integrated into this panel. The two switches are responsible for the 250 watts landing lights installed in the left and right-wing.

The Battery Switch has three positions marked EXTERNAL, OFF, and BATTERY. The different power sources are applied to the buses depending on the switch position. When the EXTERNAL position is selected, the switch connects the connected external power supply and isolates the battery. In the BATTERY position, the battery represents the electrical supply and feeds it when the generators are out of service or their voltage is lower than that of the battery. One or two generators can be added to the system when the switch is in the BATTERY position and the generator voltage is higher than the battery's output.

The Engine Ignition Switch (5) and the Ignition Select Switches (6) are ignition switches found in the overhead panel on the left side.

The ENGINE IGNITION SWITCH, which has MANUAL and NORMAL positions, serves both engines and is labelled IGNITION. When the ignition switch is in the NORMAL position, the ignition circuit is integrated on each start cycle. This means that if the engine START switch is pressed to LEFT or RIGHT, the ignition of the respective engine is automatically activated. However, if the ignition switch is set to MANUAL, power is supplied to the ignition regardless of the start cycle. This switch position is necessary, for example, if heavy icing or severe turbulence is expected since the flame in the combustion chamber may stall under such conditions. It should be noted that the starter button will not function if the ignition is in the MANUAL switch position.

The IGNITION SELECT SWITCHES is the switch for ignition selection, which consists of two switches for ENG IGNITER selection. They are marked L (left) and R (right). Here you can select the spark plug pair of the respective engine, which means either the pair number 1 for both engines or the pair number 2 for both engines. However, this switch position is only used for maintenance purposes. In normal operation, the switch is always set to BOTH, i.e. both spark plug pairs of the engines are used simultaneously.

ICE AND RAIN PROTECTION PANEL

The Ice and Rain Protection Panel refers only to the windshield of the Twin Otter, so it could also be called Windshield Panel. It is located to the right of the overhead panel above the co-pilot's windshield.

Although there are no published restrictions on the windshield wipers, it is recommended that they not be operated above a speed of 100 KIAS, as the wiper motor has difficulty moving the wiper blades to the centre position due to the airstream. Furthermore, they should not be left on for more than two minutes in SLOW mode, as electrical resistance can cause the fuse to blow quite quickly. In the slow setting, the wipers move rather jerky.

The switch controlling the windshield wipers has three different positions. The ON position turns the wipers on, and OFF turns them off immediately, regardless of the current wiper position. The PARK switch position returns the wipers to the home position in the centre.

When flying in icing conditions, the window heater should be set to HEAT to keep the windshield from icing up or remove ice buildups that deprive the crew of visibility.

ANTI-ICE AND DE-ICE PANEL

Let’s talk about the Anti-Ice and De-Ice Panel. Since there are no clear structures in the layout of the Twin Otter overhead panel, switches such as the reading lights are also located in this section. Therefore, we will describe all switches in the respective panels in their sensible order or arrangement. As a rule of thumb, Anti-Ice tends to prevent ice formation on the aircraft, whereas De-Ice ensures that the existing ice is removed. **Icing systems need to be activated when the temperature is below 4° degrees in any condition when moisture is expected.**

The PROP DEICE SWITCH controls propeller deicing utilizing electric heating mats at the propeller root. These prevent the accumulation of ice. Note that when ice has already formed and is melted, parts can hit the fuselage, creating loud bangs that will scare passengers.

The INTAKE ANTI-ICE SWITCH also has an ON and OFF position and controls the engine's heated air intake, which prevents ice formation at the intake.

The WING INSPECTION LIGHTS SWITCH controls lights aimed at the wing leading edge. These allow inspection of the wings at night. The pilot can observe ice accumulation on the wing leading edge and initiate countermeasures if necessary.

The INTAKE DEFLECTOR SWITCH extends the deflectors in the engine intake and is marked with the positions Retract, OFF, and Extended. To extend, one must click the switch to EXTENDED with the mouse pointer until the so-called Doll's Eyes indicator is on EXT. The switch must be moved to the RETRACT position to retract the

Deflectors. The switch is held until the EXT indicator on the Doll's Eyes goes out. Note that this is currently not modelled in this product.

The Twin Otter has deicer boots on the leading edges of the wings and the horizontal stabilizer, which can shed off accumulated ice by inflating. The deicer boots switches are responsible for deicing the wing's leading edge and controlling the deicing boots mentioned above. The first switch has three positions: OFF, MANUAL, and AUTO. The pilot can initiate a de-icing cycle for any four surfaces at will in manual mode. In contrast, in the AUTO mode, depending on the position of the FAST/SLOW switch, a cycle is started every 60 seconds or 3 min, respectively.

The FAST/SLOW switch determines the inflation cycle. In the FAST switch position, the edges are inflated at a rate of 5 seconds. Inflation begins with the inner wing segment. The outer wing segments take their turn, followed by 3 seconds for the right horizontal stabilizer and 3 seconds for the left horizontal stabilizer. The remaining 44 seconds are inflation times and standby times, respectively. In SLOW mode, the cycle is repeated only every 3 minutes. The inflation time for each edge remains the same, but the standby time increases to 164 seconds.

The INNER/OUTER switch can be used manually to select which edge segment to inflate. After pressing the switch, it jumps back to the centre position.

The LEFT STAB/RIGHT STAB switch also has three spring-loaded positions. It selects the horizontal stabiliser's right and left edge in manual mode. This switch also jumps back to the centre position when released.

LIGHTING AND GENERATOR PANEL

Since the individual overhead sections in the Twin Otter are not named, we have given this part the name Lighting and Generator Panel - knowing that this is also where the bleed air and temperature controls are located.

PANEL 1

The LIGHTING EMER switch has the positions ARM, TEST, and DISARM. Should the 28V DC power supply fail when the switch is set to ARM, the emergency lights in the booth will automatically illuminate. Once power is restored, the emergency lights will turn off, and the switch will remain on its ARM standby. The pilot does not have to intervene here. The test function can be used to turn on the emergency lighting.

The GENERAL, PASSENGER READING, AND ENTRANCE LIGHT SWITCHES are not animated in the Twin Otter, so we won't go into detail about them. The lighting of the turboprop is implemented via knobs, which we explain in this and the following section.

The STAB DEICE PRESSURE LIGHTS are illuminated when pressure is sent to the wing leading edges of the horizontal stabilizer. The bleed air pressure controls the inflation of the deicing boots on the horizontal stabilizer. However, the lights only indicate that air pressure is being sent and not whether the boots are functioning.

PANEL 2

See chapter on Icing.

PANEL 3

The ANTI COLLISION LIGHT is a red strobe light - also called a Beacon Light - usually positioned on the tail or fuselage, and a white strobe light (strobe) mounted on the wingtips. Many aircraft also have a second Beacon on the underside of the fuselage. However, our Twin Otter has only the red light on the tail.

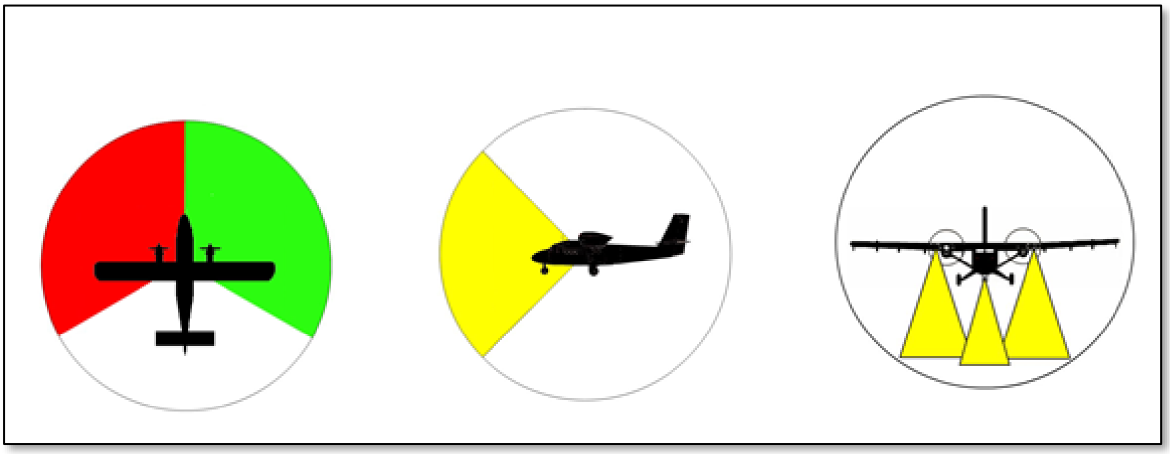
The POSITION LIGHTS are located on the wingtips (red and green) and the tail (white).

The two switches, NO SMOKING LIGHT and FASTEN SEAT BELT LIGHT, control the illuminated cabin signs No Smoking and Fasten Seat Belt, located in the passenger cabin on the right side, on the right side wall behind the co-pilot. The right bus-powered the system and runs through the FLT COMP LT fuse on the circuit breaker panel.

The FLIGHT COMPARTMENT LIGHT switch activates the two lights mounted above the seats at head height. They have a red disc for dim light and can also be dimmed.

The STROBE LIGHT (on panel 5) controls the white flashing light on the aircraft's roof. Note that there is an additional beacon switch in the photograph that our model does not have.

As with watercraft, aircraft position lights are divided into three different sectors and should be operated during the day and at night for safety reasons.



The CAUTION LIGHTS SWITCH three positions marked as DIM, BRT, and TEST. The Caution Lights can be tested for proper operation; once the switch is moved to the position, all 18 lights on the Caution Light Panel should be illuminated. In addition, the stall (stall) horn will normally sound.

The TAXI LIGHT SWITCH controls the taxi light, used exclusively for taxiing on the apron. It is mounted on the nose wheel and thus points in the desired direction even when turning the Twin Otter.

The PITOT HEAT SWITCH is responsible for heating the Pitot tube. It should not be operated at outside temperatures above 8 degrees Celsius; otherwise, there is a risk of overheating.

The TEMPERATURE controls have, of course, no function in the simulator but can be set.

The BUS TIE SWITCH connects or splits the two DC buses. When the Bus Tie switch is in the NORMAL position, both DC busbars are powered simultaneously by both generators. In the OPEN position, the DC buses are separated, meaning that the left generator and battery power the left DC bus, and the right generator powers the right bus. Separating them by the switch described is useful if the generators do not run synchronously.

With the GENERATOR LEFT AND RIGHT SWITCHES, the generators are activated. After startup, they are switched on at an idle speed of 55% Ng +15 %. A relay protects the circuit against over-or undervoltage. If a warning appears on the Caution Panel and the generators are switched online, the generator must be briefly reset via the RESET position.

PANEL 4

The instrument panels can be dimmed differently on the pilot or co-pilot side. The left knob is labelled CONSOLE FLAP & TRIM PNL LTS and operates the powerplant and trim consoles. The right knob is labelled PLT ENG INST & EMER PNL LTS and operates the pilot side, including the Emergency Panel.

PANEL 5

The rotating knob, marked with the words CO PLT RADIO & V/A PNL LTS, can be used to adjust the light intensity of the overhead panel and co-pilot instruments.

THRUST LEVER UNIT

The thrust lever unit, called Powerplant in the following, is located at the beginning of the Overhead Console. The Powerplant is controlled by three different pairs of levers in the Power Quadrant Section. Each consists of two levers used for Fuel, Prop, and Throttle. All levers have certain safety mechanisms to prevent unintentional operation.

THE FUEL LEVERS

The Fuel Levers have two positions marked ON and OFF and therefore only serve as Fuel Cut-Off Levers and not as Mixture. Thus, they only cut off the fuel and do not allow any mixture to be applied to the turbines, like something on piston Morot planes. Each lever is preloaded with a spring to prevent accidental engine shutdown. In addition, a plastic cover is also found in some models to prevent accidental shut-off. The fuel levers are directly mechanically connected to the fuel shut-off valve. This is located between the Fuel Control Unit and the Flow Divider. The fuel levers must always be in the OFF position while the engines are shut down. Otherwise, there is a danger of fuel entering the combustion chamber as soon as the engine is rotated by the starter, which can inevitably lead to a hot start.

THE PROPELLER LEVERS

The propeller levers also called prop levers, control the governor, regulating and limiting propeller speed. The levers can be moved continuously in the INCREASE and FEATHER range, i.e. between maximum and minimum RPM, as well as the Feather position, which moves the propeller blades into the gliding position to reduce drag in the event of an engine failure. The Prop Levers allow the pilot to adjust the propeller rotation speed from 75 to 96% NP.

A Propeller Lever Stop, or interlock system, is installed in the Prop Lever quadrant. This prevents the levers from being pulled back to behind the Idle Stop. This interlock is activated when both propellers are less than 91% NP. The interlock is deactivated again when a Prop Lever is pushed forward, i.e. above 91% NP.

The Prop Levers are set to the maximum speed at startup; this causes the propeller to have the smallest possible angle of attack at the best efficiency.

THE POWER LEVERS

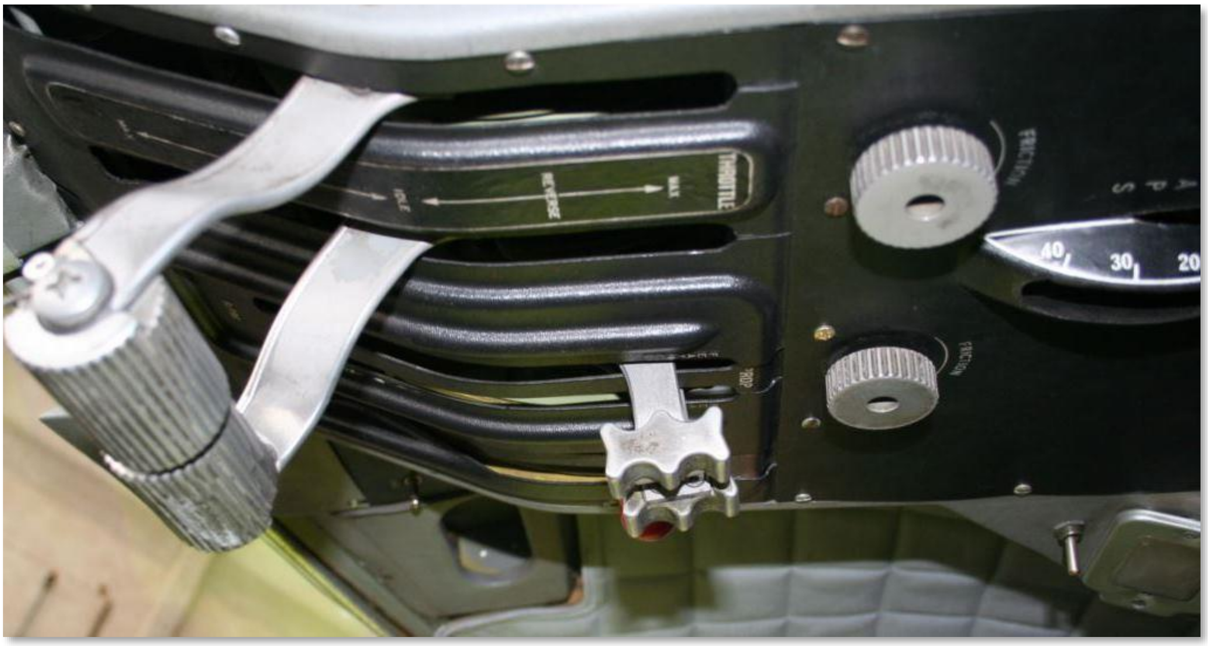
The Power Levers are also called Throttle and operate in the MAX (Full Power) range in forward thrust and MAX in reverse thrust. The intermediate positions are marked IDLE (idle) and REVERSE (reverse thrust).

An Anti-Reverse Stop is installed before the reverse range to prevent unintended reverse thrust. This safety mechanism can be unlocked by the pilot using a backward rotating motion to pull the Power Lever into the REVERSE area. It is impossible to bring the Power Lever into the reverse range while the Propeller Levers are set at less than 96% NP. The interlock will not be released until one Prop Lever is above 96%.

The Power Lever is mechanically connected to the FCU (Fuel Control Unit) and the Prop Governor. The movement of the Power Lever in the Forward Thrust Range, between MAX and IDLE, only affects the FCU. Whereas the Power Lever in the REVERSE range, between IDLE and MAX, allows the FCU to disengage, gaining control of the Beta valve. The Power Lever directly influences the propeller blade position (Beta Mode Blade Angle).

The RESET PROPS warning light appears when the Power Levers are set below 70% NG while the Propeller Levers are at 70%, i.e. at the mechanical stop. A microswitch is activated here, and the above warning is seen on the Annunciator Panel. The reverse range can thus not be used unless the interlocks are released by advancing the Prop Levers. This will clear the Reset Props warning.

Behind the Lever unit are two knobs called FRICTION LOCK. These are used to adjust the resistance of the levers. The left knob is for the Power Lever, and the right Friction Lock is for the Prop Lever. The knobs are used to increase the resistance of the levers so that they do not slip out at the selected position due to vibrations, for example. Of course, pilots can also use this mechanism to choose their individual preferences in the heaviness of lever operation. Each knob is labelled with FRICTION and marked by a directional arrow.



Especially in rough terrain, such as at Murray Island Airport (YMUI), the Twin Otter wobbles extremely during takeoff. The pilots set the friction locks high to prevent the power levers from sliding backwards during takeoff due to a bump or strong vibration.

CIRCUIT BREAKERS

The circuit breakers are not simulated in this product, and the following text is provided as additional detail.

The largest fuse panel is located to the left of the pilot's head on the inside wall next to the cockpit door. Other fuse panels are scattered around the cockpit and can be found, for example, at the rear of the overhead or in the centre console. Take your time and look around the cockpit; you will find the most exciting things here.

If a fuse needs to be reset (RESET), pilots proceed as follows: Pull up the fuse button, wait 2 seconds and then push it back in. If the fuse has popped out on its own, push it back in if necessary and as long as safety is assured. However, you can simply pull out a fuse (PULL) to disable a system or switch as a purely precautionary measure. Pilots check the fuse boxes and panels when the manual talks about CHECK. Here, however, no action is taken on individual fuses.

Fuses can also significantly limit flight operations, as from Canada. An Eastern Flying Service DHC-6-300 with registration C-GIED was conducting a cargo flight from Goose Bay to Nain, Newfoundland. About 55 miles north of Goose Bay, the right propeller suddenly went into feather position. The crew pulled the PT6-A engine to the IDLE position, went through the Propeller Emergencies Checklist, and notified air traffic control in Goose Bay of the return. Shortly after the event, the propeller popped out of the feather position and right back in, the left propeller beta light illuminated, prompting the pilots to shut down the engine. Now that this checklist had also been completed, the pilots communicated with the maintenance facility for the DHC-6 and pulled the fuse for the Beta system. The engine was now restarted, and the propeller operated normally. The Twin Otter landed safely in Goose Bay sometime later without further incident.

FLIGHT INSTRUMENTS

The flight instruments are mounted in a shock-mounted flight instrument panel and are located in front of the pilot and the co-pilot. The six basic flight instruments for instrument flight are the Air Speed Indicator, the Artificial Horizon, the Altimeter, the Turn Coordinator, the RMI, and the Vertical Speed Indicator.

PILOT'S INSTRUMENTS

All buttons of the flight instrument panel can be operated with the mouse. Virtual pilots can use the mouse wheel to control the rotary knobs or activate them with the left and right mouse buttons.

AIRSPEED INDICATOR

The airspeed indicator is a conventional, pressure-sensitive measuring device. It displays the pressure, the difference between static and dynamic pressure on the display of the airspeed indicator as speed in knots. The indicator is calibrated from 0-250 knots.

- The white outer ring shows the range of full flap position from 58 (VSO)-95 (VFE) KIAS.
    - VFE Full Flap Extension is the speed at which full flaps can be extended.
- The green ring shows the range of 74 KIAS (VS)-160 KIAS (VMO).
- The red dashes are marked at 66 (VMC) KIAS and 160 KIAS (VMO).

- VS Minimum Steady Flight Speed is the minimum speed at which the Twin Otter can still be controlled.
- VMO Maximum Operating Speed is the maximum speed the aircraft can fly under normal conditions.
- VMC Minimum Control Speed is the minimum speed at which the Twin Otter can be flown in the takeoff configuration, i.e. flaps 10 degrees and full load.

- The blue dash was set at 82 KIAS (VYSE).
  - VYSE Best Rate Single Engine is the speed at which the aircraft must be flown in an engine failure to guarantee the best rate of climb.

ARTIFICIAL HORIZON

With the help of the Artificial Horizon, the position in space can be determined. The device is roughly constructed in two parts, one is a gyroscope, and the other is the housing. The gyroscope has displays for the current angle to the horizontal axis. The lines on the housing show the angle to the z-axis, which means by how many degrees the aircraft is tilted to the left or right. Furthermore, a display for the flight director in a yellow cross is integrated into this artificial horizon. Depending on the speed, different tight turns are flown. On approach, a 30° turn is not unusual. The crew turns the yoke until the arrowhead reaches the third line of the housing. The right turn must still be initiated with the pedals if a coordinated turn is flown.

Artificial horizons are the backbone of any aircraft. Since the pilot may lose orientation in the dark and not know where up and down are, this instrument assists him, and he maintains control of the Twin Otter in all weather conditions.

When launching the Twin Otter, the control column is pulled back until the upper 10° mark is reached. However, the rate of climb varies depending on the speed. When flying with the help of the autopilot or the flight director, the artificial horizon indicates the recommended or required control inputs with the help of the two yellow lines. For example, if a change in altitude is desired, the horizontal line moves up or down. For a

When changing course, the vertical line moves to the left or right. The vertical line in the aircraft's centre is on the correct course.

ALTIMETER

The altimeter shows the current altitude at the set air pressure. The white framed display in the centre shows the current altitude. The altimeter again displays the altitude in 20-foot increments. If it rotates clockwise, the aircraft will climb counterclockwise to sink.

Depending on the weather conditions, the pressure applied to the static port (static pressure) will change. The pilot must set the airfield's current pressure to ensure a correct altitude indication. He gets this information from the ATIS, but also the controller. The Twin Otter displays the American system in inches and the metric system in hectoPascal. Therefore, the pilot no longer has to resort to a calculator, a table, or empirical values when entering an area where a different system is used.

TURN COORDINATOR

It is possible to fly exact turns with the Turn Coordinator without so-called slips. If the pilot flies a left turn, the gyro indicator points to the left. If the turn is flown without rudder, i.e. without pedals, the ball of the turn and slip indicator moves to the right, and the tail of the Twin Otter drifts. The pilot must now steer with the pedals to fly a right turn until the ball is again between the two lines.

When approaching a windy airport, such as some airports in Ireland, the pedals must be used independently of the gyro and turn and slip indicator. To stay on the extended baseline of the approach course, the nose of the Twin Otter must be turned into the wind, thus preventing the aircraft from drifting off course. Such a landing is also referred to as a cross-wind landing.

RADIO MAGNETIC INDICATOR

The RMI is an indicator consisting of a magnetic compass and a radio compass. The compass rose is movable and rotates with the help of the remote compass. This is usually located in the wingtips of the Twin Otter. So it's a heading gyro that you don't have to readjust but is carried along. In addition, the RMI has two pointers that can be assigned information from other radio navigation equipment - usually ADF or VOR. In most cases, the NAV1 device is switched to the RMI. Some devices allow switching from NAV 1 to Nav 2.

The RMI allows the following information:

- Compass rose; the current heading can be read below the red triangle, in the 12 o'clock position.
- The misaligned bearing to the first ground station set.
- In addition, the instrument has a second pointer; the pilot can place a second set ground station on it here.
- The RMI is, therefore, perfect for cross bearings.
- The Radio Magentic Indicator thus primarily shows the heading to the current NDB. The RMI accesses the frequency of the ADF. The RMI has a second needle coupled with the NAV2 and allows a reference heading.

VERTICAL SPEED INDICATOR

To determine the rate of climb and. To determine the rate of climb and descent, the Twin Otter has a Vertical Speed Indicator (VSI). This variometer shows the actual rate at which the aircraft is changing altitude. The unit of the VSI is given in feet per minute.

VOR 1 DISPLAY

The VOR display in the Twin Otter is indispensable for flights with the aid of rotary beacons. In our aircraft, the VOR is displayed with the aid of an HSI, i.e. a Horizontal Situation Indicator. The HSI can do many things: a compass, a VOR receiver,

With the help of the orange knob, the desired heading can be set. The HDG selection marker can recognise the turned course. If the HDG autopilot is activated, the aircraft will follow this course. The knob with the yellow arrow determines the so-called heading. Again, the course is shown on the compass with the VOR/LOC indicator. In combination with the set, NAV1 VORs can be approached. Turning the CRS knob also allows unlimited navigation. The exact navigation will be explained in a later section.

The VOR display also has a Glide Slope Indicator for instrument approaches (ILS) to land safely even in extremely poor visibility. Two dots on the right and left sides indicate the relative position. If the aircraft is below the glide path emitted by the ILS, the spheres are above the centred white horizontal line. If the aircraft is too high, the spheres are below - seen in the glideslope scale.

The NAV warning flag appears if no VOR or ILS can be received.

There is a fantastic video from Kip on the Ground that explains this instrument in great detail: https://www.youtube.com/watch?v=Zf2-4iDnWKk

RADIO ALTIMETER

The radio altimeter or radar altimeter indicates the current altitude in feet independent of the air pressure. For this purpose, radar pulses are emitted by the system. The surface, i.e. the ground, reflects these pulses. The radio altimeter can evaluate and display the interference pattern of these reflected beams. Altitude is displayed in absolute feet above ground and therefore differs from the altitude of the standard altimeter. A Radio Altimeter is mandatory for CAT II, and CAT III category instrument approaches.

A minimum altitude, the so-called Decision Height (DH), can be set with the rotary knob at the bottom right. If the altitude falls below the DH, an audio and visual signal prevents the pilot from descending further. If the altitude falls below the DH, the crew must initiate the takeoff manoeuvre, but the runway is not yet in sight. The radio altimeter operates within 2500 feet of the ground.

VOR2 DISPLAY

The VOR2 display is a VOR-only display and therefore has no compass capabilities. Officially, this display is also called a Course Deviation Indicator (CDI) - this is a simpler version of an HSI. Turning the OBS knob on the lower right will display the heading to the VOR2, which is locked into the NAV2 frequency. The autopilot cannot access this heading, and an ILS approach is also not possible with the VOR2 display. The function is the same as the VOR1 display, so if the Twin Otter is to the left of the set heading to the VOR, this is indicated by a diagonal line in the right direction.

CLOCK

Also built into the Twin Otter is an Astrotech LC-2 on-board clock, which in the real world has a date display and a stopwatch with an additional function in addition to the time. There are also functions limited to time, date, and stopwatch in the virtual world. The Twin Otter reads the current times from the system and displays them with the onboard clock.

AUTO FEATHER PANEL

The pushbutton is illuminated with AUTOFEATHER SELECT and ARM lights. The two fields are superimposed, of which the upper PUSH ON/OFF SELECT field illuminates green when the switch is activated, and the lower ARM field illuminates yellow when the system is ready and armed for use. When both Power Levers are pushed forward to 86-88% NG (or beyond), the ARM light comes on. It goes out when either both Power Levers have been retracted, or automatic feathering of a propeller has occurred. During the Caution Light Test, the lights will also illuminate.

The Propeller Autofeather System is standard on all 300 models and is part of the basic configuration of every Twin Otter. It is one of the most important safety systems onboard the turboprop and must be activated on every Twin Otter on wheels before every take-off. The button must not be deactivated until the After Take-off Checklist has been completed. For DHC-6 on floats or skies, the Autofeather System does not necessarily need to be installed or activated since in the event of an engine failure, for example, the Twin Otter can immediately land on the water again.

The Autofeather System has a specific use: It first requires energy for the turboprop to lift off the ground. This energy is called potential energy or attitude energy and is supplied by the engines. The kinetic energy or kinetic energy is in the movement of bodies, i.e. our Twin Otter. During the takeoff phase, the DHC-6 has low kinetic and potential energy, and an engine failure with the propeller engaged acts like a brake. Therefore, the propeller of the failed engine must be brought into the feathered position as quickly as possible.

However, the Autofeather system was not developed for use during approach or landing and therefore remains switched off during these phases of flight. The explanation for this is quite simple; it is very unlikely that the power levers are pushed far forward during the landing procedure. In addition, the Twin Otter has sufficient kinetic and potential energy reserves during this phase of flight to counteract an engine failure.

INFORMATION PANEL I

Below the aircraft identification is an information panel with six lights for various information.

TRIM IN MOTION

When manual or automatic trim is applied, the TRIM IN MOTION button illuminates.

DEAD REC

The DED REC button lights up if the aircraft is in the DEAD REC of a VOR. It is recommended to fly to the next VOR or fly over the VOR by using the Heading Button; otherwise, incorrect inputs of the VOR1 receiver are possible.

G/S ARM

If a glide slope (G/S) is detected but not captured correctly, G/S ARM will illuminate. This indicates to the pilots that they have set a correct ILS frequency, and a glide slope is being received. The light will go out if the aircraft is on the glide path. If the crew now leaves the glide path for various reasons and flies too high or too low, the indicator lights up again - the pilots must return to the correct altitude as quickly as possible or make a new approach.

NAV ARM

As with the G/S ARM, when the NAV1 signal is received, the NAV ARM indicator will illuminate. The indicator will go out if the pilot flies the Twin Otter on the correct course to VOR1.

G/S CAPT

If our aircraft is on the correct glide path, the G/S CAPT indicator will illuminate. CAPT stands for captured. Once the glide path is captured, the G/S ARM indicator will turn off.

NAV CAPT

Once we have captured the correct heading to VOR1, the NAV CAPT indicator will illuminate, and the NAV ARM indicator will turn off, the same principle as the Glide Slope.

INFORMATION PANEL II

As with Information Panel I, we go from left to right on the displays here.

STALL

If the speed becomes too slow and thus the angle of attack too large, there is a risk of stall. If this happens, the yokes in many aircraft vibrate, and the STALL light appears. In addition to the haptic and visual warning, there is a loud sound to warn the crew of the stall.

In our Twin Otter, pilots are warned by the Stall light in the panel and a Stall Warning horn located behind the captain. The stall warning is activated when the DHC-6 is flying between 4 and 9 KIAS above stall speed (VS). However, VS marks here the lowest speed at which the aircraft is still controllable.

We would like to briefly discuss stall recovery, i.e., bringing the aircraft back from a stall. As described, the first signs of a stall are the warning by the stall horn and the illumination of the stall warning light. After that, we notice a so-called wing drop, i.e. the lowering of a wing, and an increase in the rate of descent. In addition, the airspeed is very low.

We now follow four steps to stabilize the aircraft:

1. The autopilot is turned off if it is active.
2. The attitude is either reduced by the pitch attitude (lateral axis), so it is best to push the nose down a bit or, in turn, bring the aircraft parallel to the horizon to generate lift on both wings. WARNING: Pilots should never push the control column completely forward. Either apply gentle rearward pressure on the control column, yielding only to resistance, or push it slightly forward until the desired pitch attitude is achieved.
3. The Power Levers are set to Maximum Power, and the Prop Levers are set to MAX RPM (96% NP). Care must be taken not to exceed the operating limits for Torque, T5, and NP.
4. The airspeed is increased to VREF, according to the weight and flap configuration.

Of course, it is important to note that if the Twin Otter enters pitch and roll behaviour during a stall, steps 2 and 3 should be performed simultaneously. However, this instruction is only valid as long as you are within the limitations of a normal flight operation. In unusual pitch and roll behaviour, step 2 is performed first and then step 3. In most cases, the aircraft will lose a great deal of altitude when the Twin Otter has flown out of the stall.

For example, if the altitude of 2500 feet is selected, turn it in and then activate the autopilot. Then ALT ALERT is pressed, now the switch next to the Yaw Damper is used to set the rate of climb or descent. Once the Twin Otter has reached the selected altitude, the autopilot automatically switches to hold altitude.

A warning tone usually sounds +/-800 feet before the set target altitude to alert pilots before reaching the set altitude.

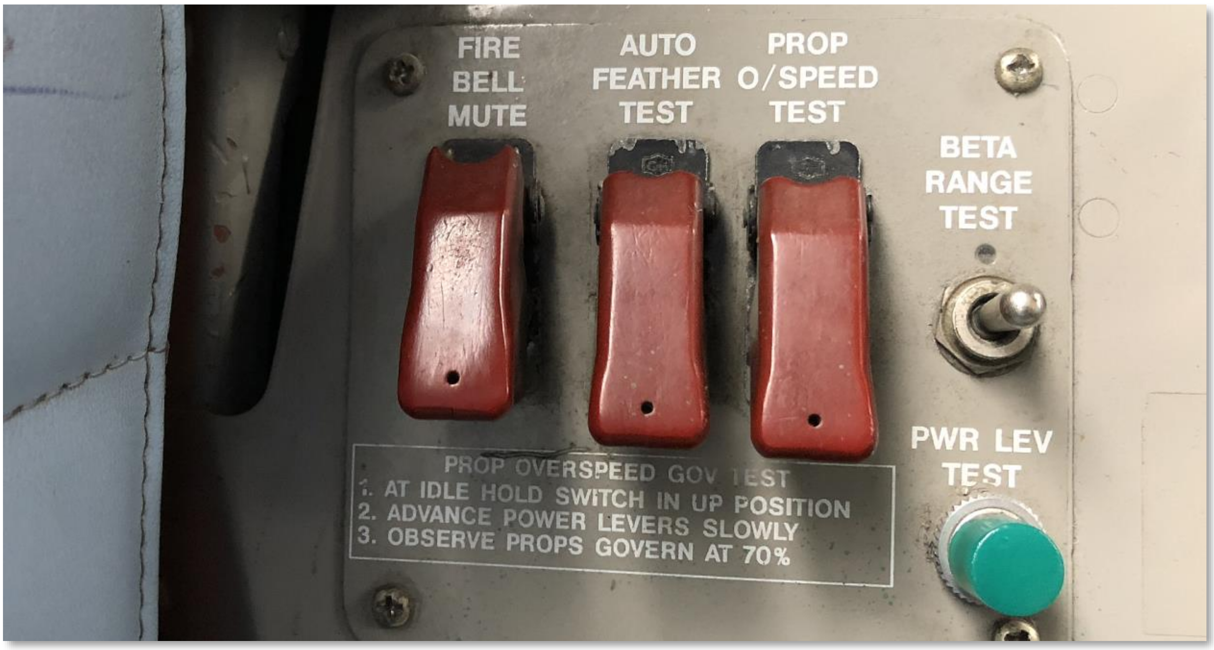
HYD C/B

This warning light was installed in all models 531 and above and is used to visually identify if the hydraulic pump fuse is pulled. This pump supplies power to the nose wheel control, brakes, and flaps.

The pressure from the hydraulic accumulator is used up relatively quickly without refilling the hydraulic pump. Short braking and operating the nosewheel steering is enough to empty the accumulator. Therefore, a check of the HYD C/B and a lamp check of the hydraulic warning lamp belong to the vital checks of the pre-flight check. The lamp reacts to light pressure during the check; if it illuminates, the lamp is OK. If it is constantly illuminated, the hydraulic circuit breaker is pulled.

ENGINE SYSTEM CHECK PANEL

A small, inconspicuous panel is located near the left cockpit door at the bottom of the panel. We refer to this arrangement of three toggle switches with a red fuse cover as the Engine System Check Panel in this book. The Fire Bell Mute Switch, the Autofeather System Test Switch, and the Propeller Governor Test Switch are hidden under the cover.



To perform the Fire Bell Test, we proceed as follows: We switch the Fire Detection Switch (see section 5.12) to TEST and immediately hear the shrill ringing of the Fire Bell. Now we open the Fire Bell Mute Switch cover and set it to ON; the bell will now stop ringing. We now push the switch's cover back down completely, which causes the switch to automatically go to the OFF position, and the ringing can be heard again. We complete the check by setting the Fire Detection Switch to the OFF position, and the Fire Bell now also quiets down again. The procedure described here should also be used for the checklist. Otherwise, a red x will appear on the virtual list.

The Autofeather system is installed on the PT6 engine to automatically move the propeller to a no-resistance position when a power loss is detected. If the torque of one of the engines drops below 20 PSI while the other is at full load at 50 PSI, the propeller is placed in a feathered position. A relay prevents the feathering system from activating the still-running engine.

The system is activated for propeller operation when the following things are met:

- It has either been manually switched, which means pressing the PROP AUTOFEATHER button to ON,
- the Torque has increased,
- or the Power Levers have been pushed forward (approx. 86 % NG).

Should one or both Power Levers be retracted, such as during a launch abort, the Feathering System is automatically disabled. An Autofeather Test Switch is installed to allow ground check before the day's first flight. The test is explained after the propeller test.

Let's move on to the Propeller Governor Check. The propeller governor is used to control the speed of the propeller. The governor will limit the fuel flow when the RPM is 6% higher than preselected with the prop levers. The system is installed to prevent the propeller from overspeeding. The maximum RPM for the PT6 engine is 96%, the Overspeed governor is set to 101.5%. This means that when the 96% plus 6% RPM is reached, the Overspeed governor automatically engages. Also, in the reverse range, the Overspeed governor prevents the RPM from exceeding 91%.

PROPELLER AND AUTO FEATHER CHECKS

1. Die Power Levers are set to idle
2. The propeller is then manually moved to the feathered position and pushed forward again. This happens with the Prop Levers once backwards over the mechanical stop pulls and then once again pushes all the way forward.
3. The propellers are brought into reverse range, or reverse thrust, once using the power levers.
4. The Prop Autofeather switch is turned ON, and we check to see if the light (on panel number 13) is on.
5. The Power Levers are pushed to 20 PSI Torque.
6. The Autofeather Test button is held, and we check if the ARM light is on.
7. Now quickly pull back the left Power Lever and see if the ARM light goes off and the propeller goes into the Feather position. This can be seen by the RPM going down and, of course, by looking outside.
8. The Autofeather Test Switch is switched to OFF, now the propeller comes out of the Feather range again and goes into the previous blade position.

All steps are now repeated from point 5 on the right side.

The Overspeed governor test checks the Overspeed governor of the engines. The test proceeds as follows:

1. The power levers are pulled to idle.
2. The Prop Overspeed Test switch is pressed and held.
3. The propellers should stop at 70% NP, as this is a standard power setting at approximately 70% at 20 PSI torque on a typical day, i.e. 15° degrees Celsius at 1013 HPA.
4. The left power lever goes to Idle, and then the Prop Overspeed Test switch is released. This is to check if both prop governors are working independently.
5. The right engine is also checked after the above steps. It is recommended to do a governor check every day.

Furthermore, we find a switch for the Beta Range Test and an illuminated push-button for the Power Lever Switch Test.

A Beta Range Test switch with two positions can also be found on the left side of the subpanel. This switch is connected to the Beta Back-up System and allows an individual or simultaneous testing of each propeller Beta Back-up System on the ground. Once the switch is clicked into the ON position, it bypasses the Power Lever Grip switch, so this means that once it is pulled up. The Power Levers are rotated and pushed back to the IDLE position, the propeller pitch angle will rotate as if it were out of service for the test duration. At the same time, the Beta Range Indicator lights and the Beta Backup Disarmed warning lights will sporadically illuminate.

The serial number 451 model introduced a green illuminated Power Lever Switch push button that uses a check to verify that the Beta Back-up Mirco switch contacts of the Power Lever are closed when the left Power Lever is above the IDLE position.

This check, together with the Beta Backup test, confirms the integrity of the entire electrical circuit of the Beta Backup system. The image above shows that the complete pressure switch light assembly is marked with the word PWR LEV TEST and is located under the Beta Range Test switch. It is not necessary to move the Power Lever to perform the test. The system test is successful if the green light appears while the switch is pressed when the Power Levers are at or above the IDLE position.

FLIGHT INSTRUMENT PANEL CO-PILOT PAGE

The co-pilot has a reduced instrument set in the Twin Otter, including the Basic Six.

FIRE DETECTING AND EXTINGUISHING SYSTEM PANEL

To react promptly in the event of an engine fire, the Fire Detecting and Extinguishing System Panel has been integrated at the top of the panel. In emergencies, pilots have the important switches and levers for extinguishing a fire directly in view.

The cockpit crew has a small cheat sheet at their disposal in a fire. First, the pilots must move the relevant power lever to the centre position and set the prop lever to feather. The Fuel Levers are completely retracted, and the fuel flow is now interrupted. The Fuel Emergency switch is also set to OFF. The illuminated Fire Pull Handle is pulled - in the sim, you can now hear the hissing sound of the extinguishing system. In the last step, the Boost Pump is deactivated. The engine should now be extinguished and turned off.

CAUTION LIGHTS PANEL

The 18 lights on the Caution Lights Panel warn the crew of problems or alert them to system configurations. The panel is divided into three rows and is located to the left and right of each magnetic compass. Each caution light has orange lettering on a black background and indicates operational problems or abnormal component conditions. The Caution Light Panel is powered by 28 volts through the circuit breaker (fuse box) from the left or right DC bus. Each caution light is connected to its fuse. Some lights are optional and are installed at the customer's request. For example, the Generator Overheat or Pneumatic Low-Pressure field is also available. In most DHC-6s, as in our version, only 17 lights are active.

A CAUTION LT switch with the three positions DIM, BRT, and TEST is located in the overhead panel.

The table below explains the possible errors that may have occurred when a warning light is illuminated. In most cases, reference is then made to the Emergency or Abnormal Checklist, which the cockpit crew must then work through. These Emergency Checklists may differ slightly from airline to airline.

CAUTION LIGHT DISPLAY OF POSSIBLE ERRORS

1. 400 Cycle Inverter Failure
2. AFT Fuel Low Level only minimal fuel in AFT tank
3. Boost Pump 1 AFT Press Malfunction of first AFT Boost Pump
4. Boost Pump 1 FWD Press Malfunction of first FWD boost pump
5. Boost Pump 2 AFT Press Malfunction of second AFT Boost Pump
6. Boost Pump 2 FWD Press Malfunction of second FWD Boost Pump

7. Doors Unlocked a door, or baggage compartment is open
8. DUCT Overheat Cabin temperature setting not according to OAT
9. FWD Fuel Low Level only minimal fuel in FWD tank
10. L Engine Oil Pressure Low oil pressure in the left engine
11. L Generator Left generator relay is open
12. L Generator Overheat Left generator is too hot or defective
13. Pneumatic Low Press Bleed Air switch off, the engine spins low, cabin heater requires too much bleed air
14. R Engine Oil Pressure Low oil pressure in the right engine
15. R Generator Right generator relay is open
16. R Generator Overheat Right generator is too hot or defective
17. Reset Props Prop Levers are not set to Full Forward at Low Engine Power Setting

When the Left/Right Generator warning lights illuminate, the generator is OFF or indicates an incorrect electrical voltage. You should attempt to reset the system, failing which the generator will be set to OFF.

If the deicing and autopilot bleed air is below 14 PSI, the Pneumatics Low Press lights will illuminate. Pilots should turn off the heater and fly out of Icing Conditions to correct the problem, then recheck the Bleed-Air switches.

The Reset Props warning light indicates that the Prop Levers have not been pushed completely forward when power is below 75%. The solution is very simple: push the prop levers completely forward. In the software, however, it can happen that the warning light Reset Props lights up, especially when using one to two Saitek Pro Flight Throttle quadrants. In this case, the levers are not matched or calibrated correctly. A slight modification to one lever usually solves the problem.

If the oil pressure is below 40 PSI, the Left/Right Oil Pressure lights will illuminate. The affected engine should be shut down as soon as possible.

The four Boost Pump warning lights alert pilots to the fuel boost pressure below 2 PSI. The second boost pump is automatically activated, but pilots must feed the engines through the other tank if both boost pumps are defective.

The Left/Right Generator Overheat, Duct Overheat, and 400 Cycle lights are not animated in the Twin Otter.

COMPASS

A magnetic compass is mounted below the windshield flap indicator on the centre bridge. Directly above it, you will find the correction card; this corrects the deviation values of the compass, which can occur due to magnetic fields in the vicinity of the compass. If the windshield heater is on, the compass information is useless.

Looks a bit worse for wear, but all fully functional

ENGINE INSTRUMENTS

This subsection describes the powerplant instruments as extremely important for Twin Otter flying.

The image shows the following instruments, which are described below.

1. Torque Indicator
2. Propeller Tachometer
3. Turbine Temperature Indicator T5
4. Gas Generator Tachometer
5. Fuel Flow Indicator
6. Oil Temperature Indicator
7. Oil Pressure Indicator

The arrangement of the engine instruments may differ on Twin Otter aircraft. In this case, the cockpit is configured individually according to the customer's requirements.

TORQUE INDICATOR

The Torque Indicator is the primary display in the cockpit and is marked with the label TORQUE PRESS PSI. The torque is measured hydromechanically with a torque pressure transmitter at the reduction gear. In colloquial terms, pressure is determined at the gearbox housing. This determined value is converted into an electric signal, and via copper wire, this analogue signal is visually displayed on the torque indicator. The display is divided into 1 PSI increments and 10 PSI intervals, ranging from 0 to 75 PSI. The Torque Indicator is the equivalent of the N1 indicator on jet engines. The larger the value, i.e. the greater the torque, the more thrust the turboprop engine produces. Torque should always be kept below the 50 PSI value.

The indicator is powered by 26 VAC (Volt Alternating Current) and protected by Torque Pressure L and Torque Pressure R in the circuit breaker.

PROPELLER SPEEDOMETER

Propeller speed (NP) is measured by a tachometer generator at the reduction gear. The tachometer generator generates an electrical current for display as (PERCENT Np RPM), which is 100% of the maximum RPM reached. The display ranges from 0-100%, with numbers at 10% intervals. The small display below from 0-9 with 1% increments allows a more accurate setting of the propeller speed.

The display generates its own current and does not require the Otter's electrical system power.

When setting the load, the propeller tachometer is the most important instrument. A typical power setting in cruise would be 76% Np and 50 PSI torque. This means that the propeller is pulled back to 76% with the Prop Levers. This RPM is now set and will be held constant.

TURBINE TEMPERATURE INDICATOR T5

To identify possible malfunctions or even a fire in the engine early and correctly, the DHC6 Twin Otter, like all other airliners, has a display of the current turbine temperature. The Turbine Temperature Indicator shows the determined temperature in the turbine. The maximum value for the Twin Otter is about 720°C.

The Twin Otter has two displays divided in steps of hundreds. The scale ranges from 100-1200° degrees Celsius with an expanded range of 550 -800° degrees Celsius. This range has 10-degree increments with one hundred intervals. Each T5 display presents the temperature of the compressor turbine downstream. Small sensors are installed in the exhaust air of the turbine and measure the operating temperature here.

The display's colours represent the Operational Range (green), the Caution Range (yellow), and the Red Range Up to a temperature of 1090° degrees that can be held for only two seconds. However, if the needle speed accelerates rapidly, a launch abort should be initiated, or engine damage such as deformation or hairline cracking may occur.

GAS GENERATOR TACHOMETER

This gauge is used to control the Gas Generator, more specifically, the speed of the turbine in which the compressed gas/air mixture drives the Power Turbine. The Gas Generator is marked PERCENT GG, which is 100% of the absolute speed of the Gas Generator.

The display has a scale from 0 to 100% in 2% steps. Every 10% step, a mark is set. A small pointer is installed on the left side of the display, allowing a more precise gas generator speed adjustment.

The speed NG, is a parameter to additionally control the functionality of the Power Turbine. Here, too, limits must not be exceeded. In practice, a power setting not exceeding 95 % NG is selected in cruise. The speed of the power turbine is about 33,000 rpm.

FUEL FLOW INDICATOR

The current fuel flow is also displayed in the cockpit. The crew can read the flow on the Fuel Flow Indicator. Engine defects can be identified, among other things, by a deviating flow rate. If there is a leak in the left engine, fuel consumption will be higher than the right engine. Furthermore, it can be calculated whether the planned fuel will be sufficient to reach the destination or whether a landing will have to be made beforehand due to a defect or strong headwind.

Fuel flow is measured in pounds per hour, and the instrument display is marked in 20-pound increments. Typical Twin Otter consumption is approximately 300 pounds per hour per side at 10,000 feet. Fuel flow decreases due to colder temperatures and low air pressure as you climb higher. Therefore, a turboprop is more efficient at high cruising altitudes than low ones. The indicator is protected by the FUEL L and FUEL R fuses.

OIL PRESSURE INDICATOR

The Oil Pressure Indicator is also used to detect faults. Here the crew can see the pressure of the oil. The oils are used to lubricate and cool the gears and other moving parts in the turboprop engine. If the pressure in the lines drops, the crew can assume that the feed lines leak. If there is too little lubricating oil in the gears, friction increases rapidly. Rapid wear is still the smallest problem; sand in the gearbox can destroy the entire engine.

The oil pressure gauge is marked with the label OIL PRESSURE PSI and has a scale in 5 PSI steps, ranging from 0 to 120 PSI. The oil pressure sensor is located on the power unit housing and is supplied with 26 VAC; the circuit is protected by OIL PRESS L and OIL PRESS R fuses, respectively.

OIL TEMPERATURE INDICATOR

Since the lubricating oil also has a cooling function, the crew must constantly check its temperature. This is done with the Oil Temperature Indicator. If the oil temperature rises too high, the crew must reduce thrust to prevent damage to the engine due to insufficient cooling.

The oil temperature gauge is marked with the OIL TEMP label and is laid out with a display scale of -50 degrees +150 degrees Celsius. The increments are marked with 10-degree dashes and are identified with numbers every 50 degrees. Each indicator is connected to a resistor that acts as a temperature sensing element in each case. The two circuits of the indicator are powered by a 28 VDC circuit and are protected by the OIL TEMP L and OIL TEMP R fuses.

BATTERY TEMPERATURE DISPLAY

The battery temperature indicator has a push-button test function. Pressing it simulates an overheat situation. The pointer, as well as the warning lamp, should be activated by this. This system is normally installed on nickel-cadmium batteries. If lead-acid batteries are used, the system is inactive.

The battery warning lamp has a trigger of 150° degrees Celsius. The graduation of the scale ranges from 120° to 180° degrees and is highlighted with the colours green (normal), yellow (caution), red (danger).

PITOT STATIC SYSTEM

The aircraft's surroundings are recorded using the Pitot Static System. This means that data flowing in here acts on the aircraft from the outside. The Pitot tube, named after Henri Pitot, determines the dynamic pressure. More precisely, the static pressure and the so-called dynamic pressure are recorded. Pitot pressure is caused by speed, which means that the prevailing (static) air pressure permanently affects the pitot tube. The air is compressed if the aircraft gains speed, and dynamic pressure is created. According to Bernoulli's equation, the measured pressure, consisting of pitot and static pressure, is converted to airspeed (indicated speed, IAS).

For reference, static pressure is called static ports, and pitot pressure is called pitot tube.

BRAKE PRESSURE AND SYSTEM PRESSURE DISPLAY

There are two displays on the lower cockpit panel called Brake Pressure and System Pressure display. Both displays have Eyebrow Lighting, operated using the overhead by the COPLT RADIO & VA PNL LTS knob. As mentioned in the virtual version of the Twin Otter by one of the three knobs.

The system pressure display ranges from 100-1700 PSI. The System Pressure Indicator shows the available pressure of all subsystems such as Flaps, Nosewheel Steering, Wheel Brakes, and optionally the Ski-Wheels.

The Brake Pressure Indicator specifically shows the pressure available to operate the brakes.

VARIOUS INSTRUMENTS, SWITCHES, AND FLAPS

This section states various instruments, switches, flaps, and fuse boxes inside the Twin Otter. We have already mentioned some switches that are not animated and will continue to discuss them as this manual progresses. However, these are not relevant for the simulation and are only for background information or a better understanding of the Twin Otter.

On the floor, for example, we find the flap for the lower part of the gust lock, in addition to the Parking Brake. In addition, the lever for the Ram Air and the switch for the Vent Fan is also located near the rudders, which can be seen on the lower right side of the picture.

The Ram Air (ram air) lever can be found on the centre post of the cockpit. The lever is labelled OPEN and CLOSED and opens and closes the Ram Air valve, respectively, controlling the flow of ram air in the system. Depending on your needs, you can regulate the flow of cold air into the cockpit. The lever can be locked in various positions between OPEN and CLOSED. If the Ram Air valve is closed, the bleed air in the mixing chamber is mixed with the interior air. The air is distributed through the air ducts, which are installed in the foot area of the booth.

A vent fan is also installed in the Twin Otter. Its function is to distribute the accumulated air in the cockpit, but it is only used on the ground. The fan is operated by the VENT FAN switch above the Ram Air lever. Its electrical circuit is protected by the CABIN VENT FAN fuse.

AVIONICS

Our Twin Otter is equipped with basic but reliable navigation and communication systems. They are all well proven to stand up to the rigours of bush piloting.

- Garmin 530 all-in-one GPS/Nav/Comm solution
- Garmin 430 all-in-one GPS/Nav/Comm solution
- Bendix/King KR-87 ADF Receiver
- Bendix/King KT-76C Transponder
- Bendix/King KAP140 Autopilot
- Intercontinental Altitude Alerter
- Collins 913K Autopilot Controller (used as a repeater for the KAP140)
- Bendix/King KMA Audio Selector
- Collins FD-112V Flight Director

Note that we decided to use the default systems of Microsoft Flight Simulator because they are being enhanced continuously and are sure to work on every platform. If the implementation of other systems is requested, we will consider that.

GARMIN 530 AND GARMIN 430 ALL-IN-ONE GPS/NAV/COMM SOLUTION

The Garmin 530 and 430 combines communication radios with GPS-based navigation and a moving map to increase situational awareness. The use of the instrument is far better explained by video than by text, so we advise you to use the many YouTube videos on this topic. We like these:
https://www.youtube.com/watch?v=Vf954I-IbJI
https://www.youtube.com/watch?v=CmIZPuyw5wA
https://www.youtube.com/watch?v=U_q-5mPcBQk&list=PL1AlvGUwm14D0n_mcQScZUhooDfqMEkUx

We highly recommend updating your Garmin 530 with the works done by PMS5:
https://flightsim.to/file/4700/gns530-mod

BENDIX/KING KR-87 ADF RECEIVER

The ADF receiver is the most basic navigation instrument. When tuned to an NDB beacon, the arrow in the Automatic Direction Finder will point to that transmission station. After the frequency is tuned, the station's identity can be confirmed by the morse code.

BENDIX/KING KT-76C TRANSPONDER

A transponder is required for an IFR flight or a controlled VFR flight. The Twin Otter is equipped with a KT76C transponder from Bendix King, where you can select the mode by turning the right knob. The system has a self-test to exclude a defect at the transponder; this can be activated by turning to the TST position.

In addition to the squawk display, the KT70 also has a flight level indicator that shows the current altitude at the standard air pressure of 1013 hPa. So the number FL065 displayed above means an altitude of 6,500 feet.

BENDIX/KING KAP140 AUTOPILOT

The KAP140 autopilot does not have an automatic system found in modern airliners. In the Twin Otter, the autopilot serves as a support for the pilots during the flight. For example, the climb must be performed in a 'semi-automatic', i.e. the so-called manual autopilot mode.

At the moment of writing, this default system has problems with approaches at low speed; this has been reported to Microsoft.

MANUAL AUTOPILOT MODE

Pilots like to use the so-called manual autopilot mode in the DHC-6 Twin Otter. When this mode is selected, the horizontal (HDG, NAV, B/C) or vertical (ALT, IAS) autopilot capability remains unused. The pilot can concentrate fully on the course while the altitude is maintained automatically. Of course, things also work the other way around - the crew controls altitude while the autopilot holds course. Modern autopilots, such as those in a Boeing or the Airbus, perform the tasks automatically. The pilot has to program in the route before his flight, and the onboard computer automatically calculates altitude, course, and speed, but this is not possible in the Twin Otter.

SPEED (IAS)

An optimal climb with a constant speed can be achieved by pressing the IAS button. The autopilot will automatically change the aircraft's pitch (angle of attack) to maintain a constant speed. The pilot controls the thrust lever - the DHC6 Twin Otter does not have Auto Thrust or Auto Throttle. An automatic thrust control (Auto Thrust - designation in Airbus aircraft) or Auto Throttle (designation at Boeing) enables the autopilot to influence engine performance. In the Twin Otter, the pilot has to perform this task of optimum performance; the more thrust is given, the steeper the DHC-6 can climb. For example, power is maximised if the crew wants to gain altitude quickly. However, thrust can also be throttled back to save costs, resulting in a lower climb rate. A mixture of both allows the most economical flight.

ALTITUDE (ALT)

The Twin Otter cannot automatically change altitude at a preset rate of climb or descent. Pressing the ALT button will hold the current altitude. Altitude changes are performed in vertical manual mode or with IAS mode. The desired altitude can be set in the SET ALTITUDE panel. With the help of the United Instruments 5506L-S altitude warning system, the climb or descent is automatically stopped at the set altitude.

HEADING (HDG)

When the Heading button is pressed, the aircraft follows the selected heading. The heading is selected with the orange knob on the compass. The Twin Otter will follow this heading when the HDG button is pressed. A change of heading is possible at any time and is implemented immediately. With an Airbus or the McDonnell Douglas MD11, a heading change must be confirmed manually by pressing the heading button - this is not the case with the Twin Otter.

NAVIGATION (NAV)

Two components are needed for navigation (NAV) with radio beacons (VOR). One is a radio receiver, and the other is an existing radio beacon. If the VOR frequency is set correctly, the NAV button can be used to fly to the desired radial (course, CRS) of the VOR. The NAV1 frequency can be set in the GPS (section 6.5). The desired course is turned in with the yellow arrow on the compass. The moving line between the tip and the end of the arrow indicates whether the aircraft is to the left or right of the selected course. If the tip, middle, and end are in a straight line (without deviation from each other), the aircraft is flying on a direct course to the

VOR. Since the VOR becomes less accurate as it is approached, the Twin Otter has the so-called DED REC mode (section 6.3.4) to maintain the current heading as the aircraft flies over it.

APPROACH MODE (APPR)

For an automated approach, the APPR button has to be pressed. Again, a VOR, preferably an ILS, and the correct set frequency are considered prerequisites. When pressing the APPR button, the set heading is flown, the altitude is changed automatically for an ILS approach; for a VOR and LOC approach, the altitude change must be done manually (an ILS has a glide path transmitter, a VOR, and LOC do not).

BACK TRACK (B/C)

The B/C (Back Course) button is rarely used. It uses the LOC or ILS signal, which is emitted in the opposite direction of the normal approach. It is important to note that the glideslope of the ILS must not be used. The display on the compass should also be used with caution since a displayed deviation to the left of the centreline means a correction to the left. So this means - left is right, and right is left - really very confusing. Therefore, in real flying, this method is very rarely used.

INTERCONTINENTAL ALTITUDE ALERTER

Altitude Alerter System distributed by United Instruments is coupled with the Collins autopilot. This instrument uses acoustics and visual indicators to notify the pilot when certain parameters are reached. The altitude accessed by the Altitude Alerter System is dialled into the SET ALTITUDE panel.

BENDIX/KING KMA AUDIO SELECTOR

The Audio Selector allows the pilot to connect audio sources to the speaker or headphone and connect the microphone to one of the communication radios or headphones of other people in the aircraft. It also contains a separate receiver to indicate if the aircraft is over a marker beacon.

COLLINS FD-112V FLIGHT DIRECTOR

The Flight Director is a visual aid for the pilot. On the ADI, the Flight Director is shown with two lines. The required control inputs are displayed on the selected autopilot modes and set parameters. This means that the recommended angle of attack and the lateral position are displayed on the artificial horizon. For example, the vertical line points to the left if a new heading is set to the left of the current one, or the horizontal line moves down if a lower altitude is selected.

OPERATIONS

A SHORT GUIDE FOR SAFE FLIGHT

This manual section discusses the many important issues to perform a safe flight in a Twin Otter**. It is NOT intended as a step-by-step manual** that will come later. You may know most of this if you are an experienced flight simulator. Feel free to skip to the next chapter!

FLIGHT PREPARATION

Flight preparation of the Twin Otter DHC-6 includes the following measures to ensure a safe flight. Before each flight, the Pilot in Command must familiarize himself with the information required for safe flight performance and satisfy himself with the airworthiness of the aircraft. This includes, in particular, the proper condition of the aircraft. There must be no pending maintenance events that could limit operations. This information can be found in the logbook of the aircraft.

Furthermore, defects found during the pre-flight inspection, for example, must be entered in the list of deferred complaints. It is important to note that the technical logbook and the Preflight entry must be signed before each flight.

Each pilot must ensure that the fuel refuelled is sufficient for the flight duration. The actual amount on the Aircraft must be exactly, or greater than, the amount of fuel calculated on the Flight Execution Plan. A difference downwards is not allowed because flight planning calculates the worst-case scenario. There are various surcharges and reserves that must be included in the calculation.

In addition, the crew must inform themselves about the weather situation. The weather at the departure point, the en-route weather, and the destination are important here. Whether the flight can be conducted according to VFR (visual flight conditions) or IFR (instrument flight rules) must be checked. The weather of the alternate airport must also be queried. If fog, heavy rain, hail, or snow does not allow the approach to the destination, the weather at the alternate airport, also called alternate aerodrome, must be better. This means better visibility and a higher cloud base.

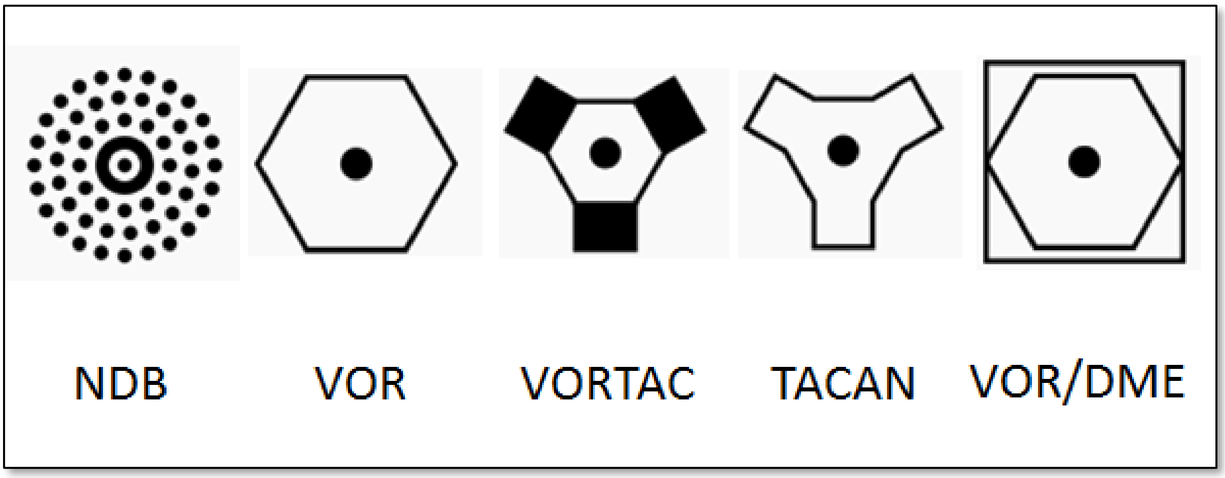
Also important for the pilot are the NOTAMs (Notice to Airmen), which contain information about the airport, the navigation systems, and the airspace that will be touched during the flight. The NOTAMs contain everything that might be defective, restricted, or temporarily disabled. For example, this Notice includes a shortened runway due to construction or a rotating beacon turned off for maintenance.

Since passengers' or cargo distribution affects the aircraft's attitude, each pilot must also know the load and centre of gravity. Here, so-called load sheets or weight and balance sheets are prepared. They enable the control of the proper load distribution and compliance with the operating limits. When cargo is transported, it must be ensured that the cargo items are properly secured against slipping.

FLIGHT ROUTE AND NAVIGATION

The flight route planning includes calculating the flight duration, the speed over the ground, the heading, and the required fuel under navigation aids such as NDB, VOR, DME, and GPS.

To make the following chapters palatable to our inexperienced readers, we would like to make a short excursion into aircraft navigation of all kinds. Let’s start with the navigation beacons that are used by aircraft.



Navigation symbols

NDB

NDB is the abbreviation for Non-Directional Beacon. NDBs were the first antenna systems for airborne navigation. The range of the long-wave transmitter is given as a range of 15 - 200 nautical miles - depending on power and design. Compared to the VOR, an NDB is a very simple navigation aid. In Germany, more and more NDBs are being switched off. However, they are more suitable in valleys, as VORs cause too strong reflections on the steep slopes of mountains. NDBs are also indispensable in remote areas, such as on the island of Tuvalu, which can only be found by an NDB, for example.

VOR

A VOR (VHF Omni Directional Radio Range) is a rotating beacon. VORs were first developed for airships and used there. Again, the range depends on the design and altitude. A High Altitude VOR (HVOR) has a range of 130NM at an altitude of 45,000ft. VORs have the advantage that the receiver can take the direction of the radio beacon. The bearing is obtained by a special coding of the signal and is evaluated by the receiver. Many VOR installations transmit the direction and the range; from both pieces of information, the time of the VOR's overflight can be predicted. By combining several VORs, almost any number of possible flight routes can be created. Thus VORs can be used as a reference for cross-country flights without setting a direct course. What is described here is called VOR/DME.

AIRWAYS

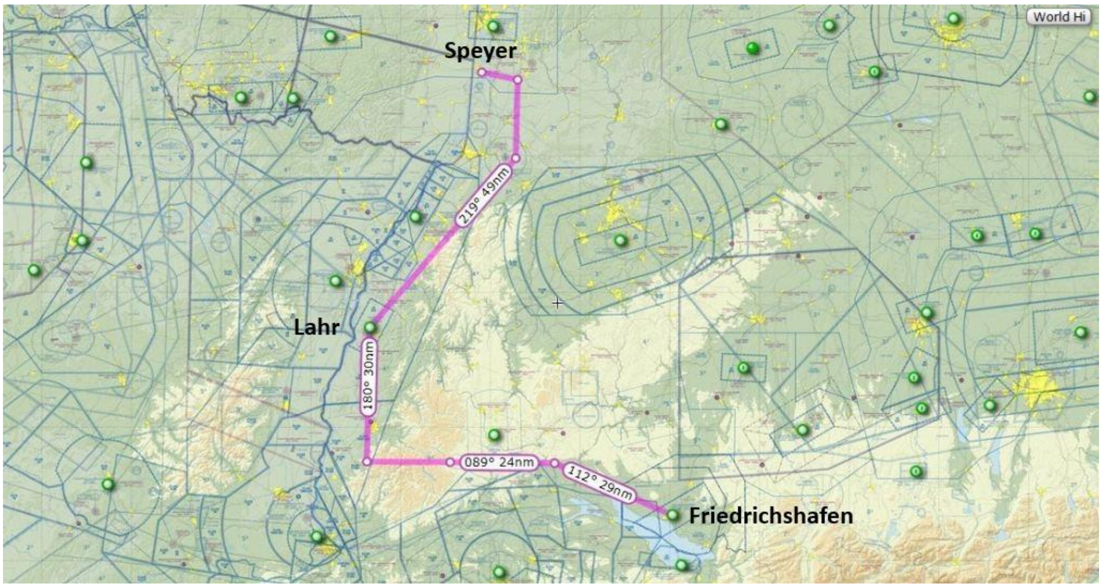
Modern navigation in IFR flight is based on airways. Intersections (intersections of VOR radials) are used to define airways for upper (from FL245) and lower airspace (up to FL245). Intersections form points on the route that must be flown over. The points also called fixes, have five letters and are partly based on geographical features. For example, southwest of Mannheim, there is the MANEM intersection. On approach to Stuttgart, one can fly over the points VATER and UNSER.

The airways are located between two fixed points and are partly one-way - flights are only allowed from south to north or from west to east on the respective airway. Also frequently applied restrictions on flight altitude or whether an even or odd flight level must be flown.

FLYING WITH NDB AND VOR

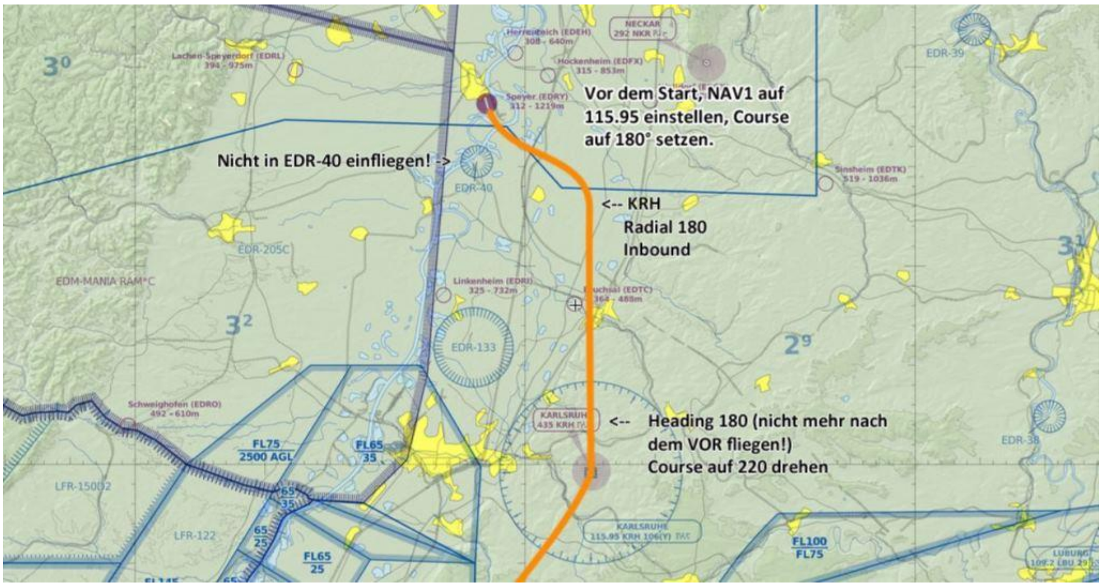
Since it is probably not easy for newcomers to follow all navigation executions, such as NAV1, ADF or the ILS and NDB, we would like to give a few examples of VOR and NDB navigation using a small sightseeing flight in southern Germany. To avoid making things too easy, we will avoid certain airspaces, we will not fly by sight - i.e. we will not orient ourselves by roads or rivers - and we will otherwise stick to the common (VFR) flight rules. We start our flight at the small airfield in Speyer (EDRY). The destination is the Bodensee airport Friedrichshafen (EDNY). The route should go over the Black Forest, and we want to greet our aunt in Lahr.

Again, **this is not intended as a flight you need to perform**; it is just intended as an example of how aircraft follow routes.



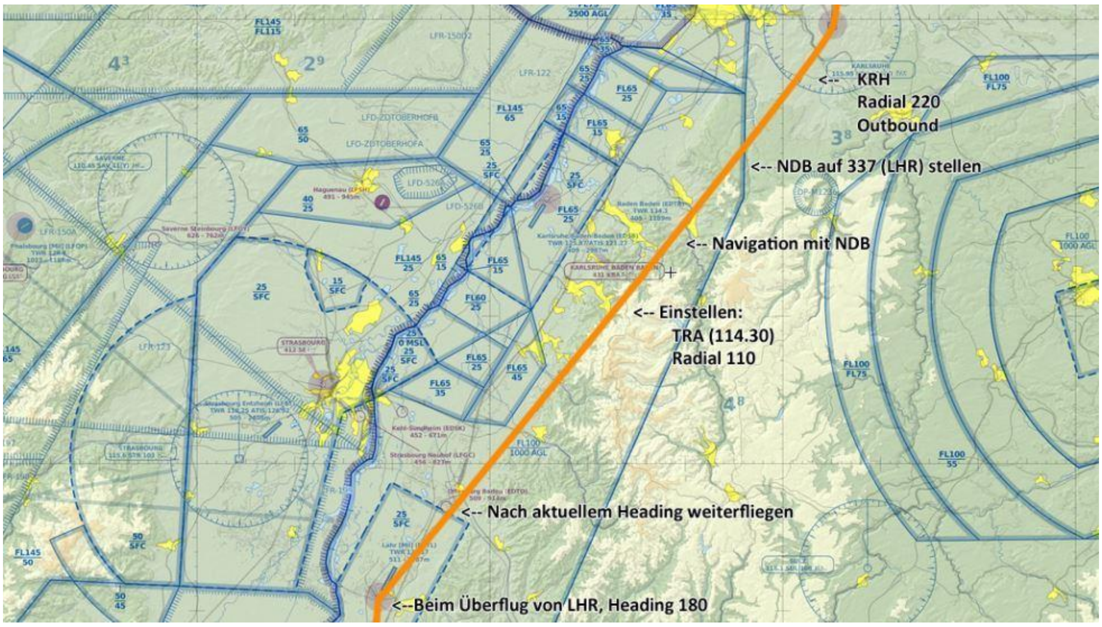
Speyer Routing, © skyvector.com 2014

With these specifications, it is now up to us to construct a route that we can fly using NDBs and VORs. For the sake of simplicity, we will explain in parallel below how the route comes about and how the various phases are represented in the aircraft.



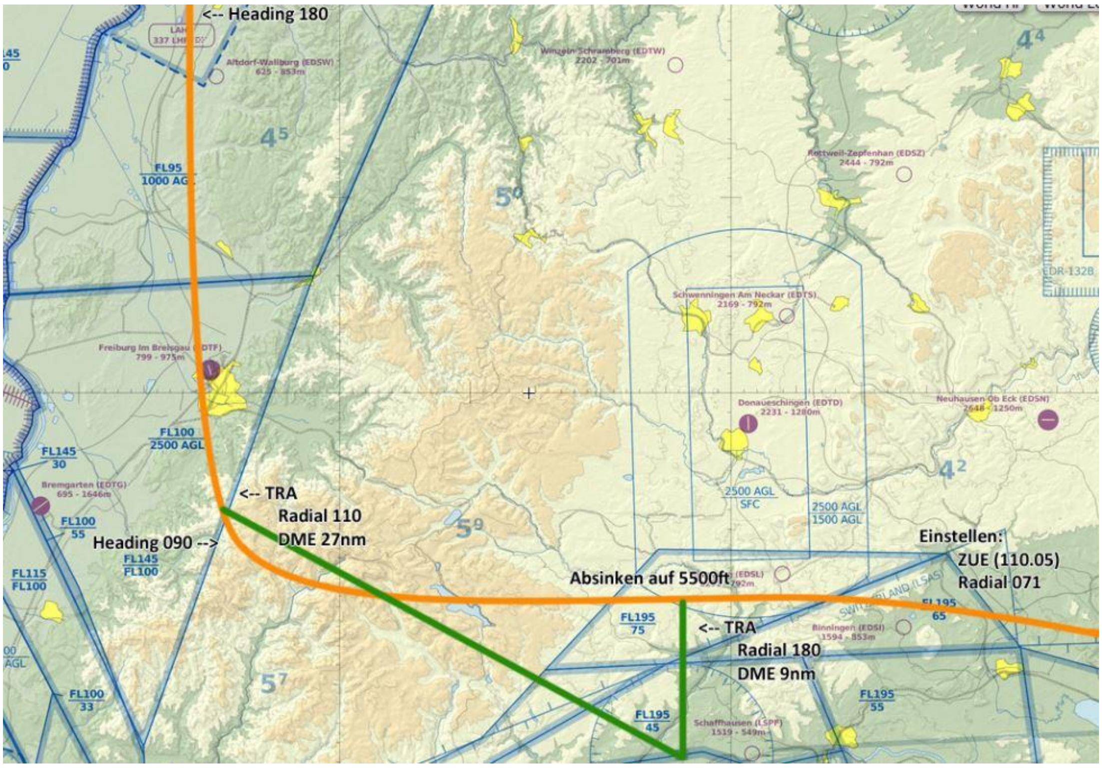
Routing Part I, © skyvector.com 2014

After takeoff in Speyer, we fly east. A heading of about 110° should be enough to safely pass the Philippsburg nuclear power plant. Around nuclear power plants, there is often a restricted airspace zone; this is indicated by the blue circle with the marking EDR-40 on the chart. Furthermore, the NAV1 frequency is turned to 115.95; the VOR KRH serves us as the first point of the route to Friedrichshafen. The course is now set to 180°. We will see this on the HSI if we receive the VOR correctly. Shortly before passing the VOR, we no longer orient ourselves to the VOR display of the HSI, but must maintain our heading due to the blind angle. At the same time, we turn the course to 220°.



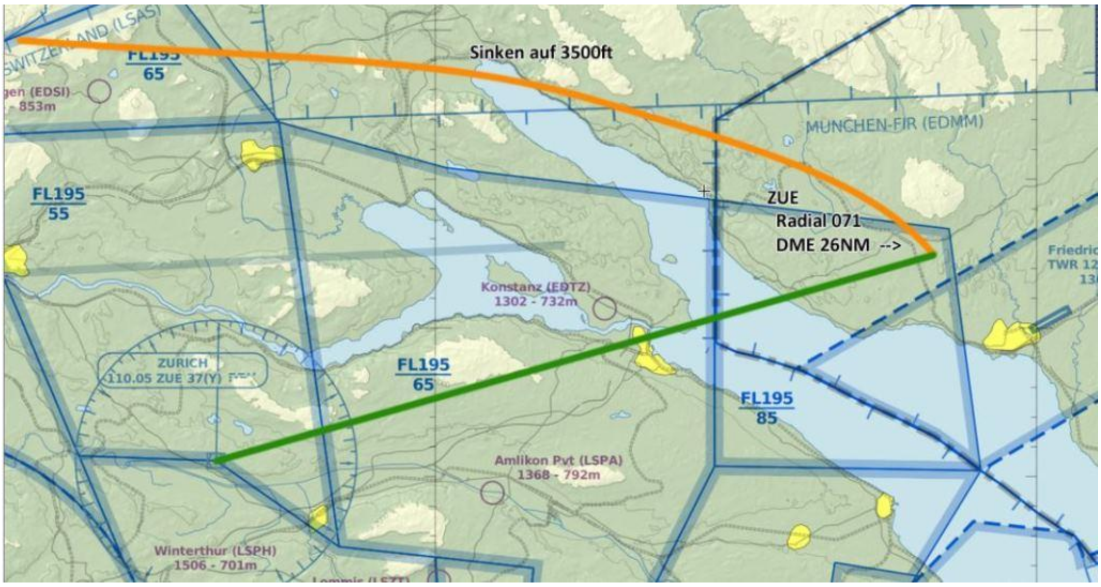
Routing Part II, © skyvector.com 2014

After the overflight, we follow the 220° course of the KRH VOR outbound, i.e. we move away from the ground station. At an altitude of about 6,500 feet, we fly in the direction of the special airfield Lahr. While we perceive the Baden airport Karlsruhe/Baden-Baden on the right side, we turn on frequency 337 of the Lahr (LHR) NDB at the ADF. For the next part of the flight, we follow the NDB signal. Since the NAV1 frequency is not needed, we use the opportunity to set a new VOR to continue from the LHR NDB towards Friedrichshafen without any problems. The Trasadingen (TRA) VOR in Switzerland serves as a reference for further flight. We will now use the full range of the VOR navigation, but we will not fly over the VOR but use it only as an auxiliary point. As a course, we set 110°.



Routing Part III, © skyvector.com 2014

During the overflight, which is evident by a wobble and a 180° turn of the RMI display, we follow the heading 180 south until we reach the radial 110° of the Trasadingen VOR. The distance to TRA should be about 27 nm. A left turn of 90° brings us to a heading of 090°. Since our flight is heading east from now on, we have to change our attitude, which means we have to fly on an odd flight level. This is used to descend to 5,500 feet to avoid entering Zurich airport airspace. After the heading change, we can continuously change the course of the TRA VOR to verify that we are really flying the heading 090° and not being driven north by the wind or, worse, south precisely because of the complex airspace around Zurich. At the radial 140° (so enter 140° into the course), our distance should be about 11 nm. The distance is the smallest when crossing the radial 180°; the shortest distance should be about 9 nm.



Routing Part IV, © skyvector.com 2014

After passing over radial 060 at about 20 nm, we descend to 3500 feet and turn right to a heading of 110°. The NAV1 frequency is 110.05 MHz to receive the Zurich (East) VOR (ZUE). The aircraft must fly over so-called mandatory reporting points to enter the Friedrichshafen control zone. The reporting point NOVEMBER of EDNY is Radial 071° with a distance of 26 nm to the VOR ZUE. If the DME and the HSI show the said values, we know we are over NOVEMBER. Now follows the counter-approach and the landing.

We would like to refer all virtual pilots who want to deepen their navigation knowledge to the two online networks, VATSIM and IVAO, where especially newcomers get theoretical and practical knowledge through interactive training. The use of both networks is free of charge.

OPERATING LIMITS OF THE DHC-6

The Twin Otter has certain operating limitations and quirks that pilots should know. We have listed the airspeed limitations and the engine limitations.

AIRSPEED LIMITATION

The maximum airspeeds must not be exceeded under any circumstances; otherwise, long-term structural damage may result. The manufacturer's speeds allowed to be exceeded only in exceptional cases, such as a test flight during trials. VNE, therefore, means Never Exceed.

In the following paragraph, the maximum speeds for certain configurations and flight attitudes are given. This is the normal variant with standard tires and 12,500 LBS takeoff weight.

Minimum Control Speed (V_{MC})	Flaps 10°	64 KIAS
Climb Speed-Best Angle (V_{X})	Flaps 0°	87 KIAS
Climb Speed-Best Rate (V_{Y})	Flaps 10°	100 KIAS
Climb Speed -Single Engine (V_{YSE})	Flaps 10°	80 KIAS
Flaps Extended Speed (V_{FE})	Flaps 10° Flaps 10° - 37.5°	102 KIAS 93 KIAS
Flaps Extended Speed		103 KIAS
Max. Operating Speed	6.700 ft	156 KIAS
Max. Operating Speed	10.000 ft	146 KIAS
Max. Operating Speed	15.000 ft	141 KIAS
Max. Manoeuvring Speed (V_{A})	Sea Level to 18.000 ft	132 KIAS
	Over 18.000 ft	V_{MO} limited

ENGINE LIMITATIONS

The following rules apply to engine limitations, which must of course also be applied in the flight simulator:

Power Setting	**Operating Limits**						
	SHP	Torque PSI	T5 °C	NG%	NP%	Oil Press PSI	Oil Temp °C
Take-off Max Cont	620 to ISA +6°C	50	725	101.6	96	80 to 100	10 to 99
Max Climb Max Cruise	620 to ISA +6°C	50	695		96	80 to 100	0 to 99
Idle			660			40 min	-40 to 99
Starting			1090				-40 min
Acceleration		68.7	825	102.6	110		0 to 99
Max Reverse	620	50	725	101.5	91 (+/-1)	80 to 100	0 to 99

- The maximum full load may only be 50 PSI at 96 % NP. This corresponds to 620 HP (horsepower). And is not so much an engine limitation as a design limit since the engines are quite capable of more. In the event of an engine failure, the rudder area of the vertical stabilizer would not be sufficient to counteract the forces of the still active engine.
- For every 10 degrees Celsius below -30 degrees Celsius, the maximum speed of the NG throttle generator must be reduced by 2.2%.
- Normal oil pressure is 80-100 PSI at 72% NG when the oil temperature is 60 degrees Celsius. Oil pressure below 80 PSI is undesirable and should only be tolerated to complete the flight. If possible, do so at a reduced load to conserve engine power. An Oil Pressure below 40 PSI is unsafe, and the engine should be operated at minimum load or even shut down. The crew should then immediately divert to the nearest airport. However, 40-80 PSI is allowed during ground operations.
- The maximum T5 temperature may only be 660° degrees Celsius at idle. You can reduce the temperature by various methods; for example, you can listen to the NG, which is the speed of the gas generator, or simply turn off the load of the generators.
- Reverse thrust is only allowed for a maximum of 60 seconds to preserve the engines.
- Takeoff temperatures of 925° Celsius are allowed, 980° to 1090° Celsius are acceptable, provided the temperature drops back to 980° Celsius within 2 seconds.
- If the prop governor is defective, you may continue to fly with a maximum propeller speed of 101.5%.

WEIGHT AND BALANCE

Every commercial operator or airline must file weight and balance documentation before every flight. It must be possible to identify what is being flown and how it is distributed in the aircraft. The weight and balance sheet must show that the weights are loaded in balance and that the operating limits have not been exceeded. The responsible person preparing the Weight and Balance Sheet must be identified by name. The loading personnel who manage the loading process must ensure that the passengers or cargo are loaded in the locations as calculated in the Weight and Balance Sheet. Again, the person in charge will sign under the W/B Sheet. This document must be accepted and countersigned by the Captain.

Regarding the weights of the DHC-6, Twin Otter's maximum takeoff weight of 12,500 Lbs may not be exceeded under any circumstances. The manufacturer's various paragraphs, diagrams, and tables must be followed.

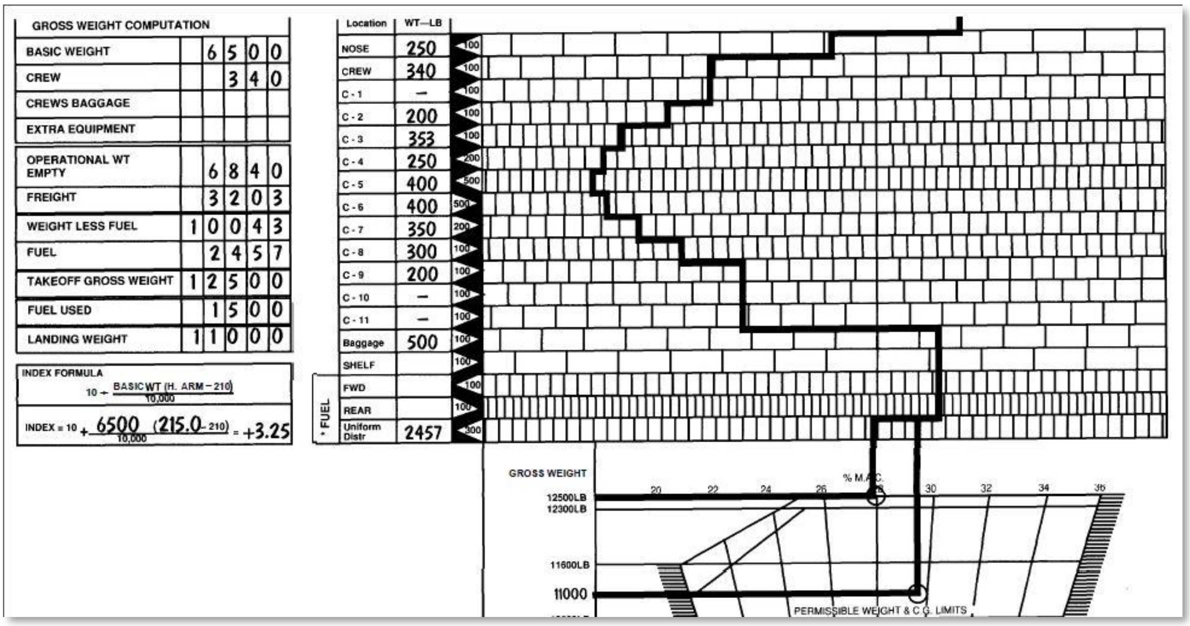
The **Standard Basic Weight**, i.e. the simple standard empty weight, is the aircraft's weight, including all equipment that belongs to the Twin Otter. Among other things, this includes oil and fuel, which cannot be, i.e. the remaining fuel remains in the lines or hollow chambers of the tank.

The **basic weight**, i.e. the **simple empty weight**, includes the standard empty weight plus the equipment that is not part of the standard equipment. That is, any item, such as the radios, propeller de-icer, or even the complete exterior paint job, that is standard equipment.

Operational Load includes the weights necessary to operate the Otter. This includes crew members, fuel, and payload. Payload refers to the usable load, including passengers, suitcases, and cargo. This weight depends on the amount of fuel to be carried. Since the Twin Otter can only be loaded to a limited extent, the payload consists of a mix of fuel and passengers or cargo. The maximum fuel load of the DHC-6 without auxiliary tanks is 2450 LBS. The max payload is calculated from the AUW (total weight) minus the empty weight (basic weight) and the fuel quantity.

The abbreviation **AUW (all up weight)** stands for the sum of all weights. The total weight of the above-mentioned maximum take-off weights must not be exceeded.

The loading of the Twin Otter is measured from a standard reference point, the Reference Point. The following loading plan shows how the Twin Otter must be loaded to keep the operating limits and the aeroplane's centre of gravity balance.



Weight & Balance Sheet

Each station on the Weight & Balance Sheet has a directional arrow that must be followed. The endpoint must be within the so-called envelope at the end of the drawn line, represented by the dashed area. If the end of the line is outside of the envelope, flying is not allowed under any circumstances. The load must be redistributed or unloaded if necessary. The performance of the Twin Otter can only be guaranteed if the corresponding parameters of the Weight & Balance are adhered to.

WEATHER

Pilots who want to take off according to visual flight conditions depend more on the weather than pilots who fly according to IFR rules. Therefore, minimum values for visibility, main cloud base, and distance to clouds are required for uncontrolled and controlled airspace. Each pilot must obtain current aviation weather reports for cross-country flights and verify that conditions along the route are correct. This information should be obtained as promptly as possible.

To get safely from one's departure airport to one's destination, the weather must be suitable at both airports and along the route. Pilots flying under visual flight rules depend more on weather conditions than pilots flying under instruments. For a VFR flight, different minima apply in airspaces; for a cross-country flight in airspace E, flight visibility of 8 kilometres must prevail, and a vertical distance of 1000 feet to clouds must be maintained.

METAR

The weather is published with a so-called METAR at larger airfields and airports. METAR stands for Meteorological Aviation Routine Weather Report, whose messages are updated every 30 minutes. A METAR is not easy to understand for a layman. We will not explain a complete listing of all details here but explain a simple standard METAR.

EDFM 281420Z 20007KT 9999 FEW032CB 27/26 Q1028 BECMG BKN030 TS

The METAR was published in Mannheim (EDFM) on the 28th of the month at 1420 UTC (281420Z). The wind is blowing from 200° at 07 knots (20007). Visibility is reported at 9999m; this is interpreted as visibility greater than 10 kilometres (9999). There are scattered (FEW) clouds at 3200 feet declared as CB (cumulonimbus) (FEW032CB). The temperature is 27°C, and the dew point is 26°C (27/26). Currently, the atmospheric pressure is 1028 hPa (1028). The trend BECMG (becoming so expected) tends to worse weather with almost closed cloud cover (BKN030) and thunderstorms TS.

TAF

Like METAR, the Terminal Aerodrome Forecast (TAF) also gives weather forecasts for airfields. Here, too, we want to explain a short example:

TAF EDDF 081000Z 0812/0910
22010KT 9999 FEW040
TEMPO 0814/0818 RA BKN030CB
TEMPO 0900/0907 4000 BR

This TAF was published for Frankfurt Airport (EDDF) on the 8th of the month at 1000z (081000z). It is intended for the 8th of the month, 12z to the 9th at 10z (0812/0910). As of the time of publication, winds of 220° at 10 knots (22010KT), visibility greater than 10km (9999), and scattered clouds at 4000ft (FEW040) can be expected. Furthermore, there may be brief (TEMPO) weather changes between 14z and 18z (0814/0818) towards rain and many thunderclouds at 3000ft. In addition, there may be a change in visibility to 4000ft (4,000m) and fog during the night from 00z to 07z (0900/0907) (BR).

GAFOR

With the help of the General Aviation Forecast (GAFOR), en-route flights in the VFR area can be planned. It includes information such as wind and temperature at several altitudes up to FL100 or zero degree limit and classification of visual flight conditions. Abbreviations, numbers, and colour-coded maps allow a quick assessment of the weather; for example, Charly means C for Clear in blue. So 10-kilometre visibility and 5/8 cloud cover from 5,000 feet and higher.

NOTAMS

In aviation, one hears again and again about so-called NOTAMS, i.e. Notice to Airman. These messages for airmen contain relevant information concerning airspace, airports, restricted areas, navigational beacons. Nevertheless, let us briefly explain what a NOTAM exactly is.

In detail, it means that all short-term information for a pilot, such as the condition of airfields, failure of navigation facilities, or activation times for restricted areas, are published via a NOTAM. NOTAMs are basically only short-term changes to the Aeronautical Information Publication (AIP). An AIP, or Aeronautical Information Publication, is a standardized reference book containing aviation-related information and regulations. Generally, an Aeronautical Information Publication applies to a single country, but it is possible in principle for several countries to issue a common AIP.

However, it cannot be guaranteed that the AIP will be amended or supplemented in some cases. In this case, in addition to short-term changes, long-term changes to the AIP and changes that require a detailed written explanation may be issued as NOTAMs. Thus, a NOTAM may be valid for longer than 3 months.

As part of his flight preparation, the Pilot in Command must familiarize himself with all documents available to him before each flight. This includes the current NOTAMs concerning the flight. These are, as mentioned above, the NOTAMs concerning his departure airport, his destination aerodrome, and as far as necessary and desired the alternate airports and information about his flight route.

MAPS

For VFR navigation, we use the VFR route charts. The charts contain terrain, minimum flight altitudes, airspaces, airspace structures, and radio frequencies. For example, a VFR aerodrome circuit chart contains all necessary information about the airport, including aerodrome circuit altitude, aerodrome circuit direction, noise restrictions, aerodrome operating hours, and special features.

On the other hand, IFR charts are designed for operations under instrument flight rules. The so-called E (Lo) enroute charts show all airways and waypoints on the chart.

The approach charts for the respective airport can be found in the, e.g. Jeppesen folder stored in our Twin Otter. Here all approach manoeuvres of the airports are published worldwide.

We strongly advise all simmers to familiarize themselves with the charts. Especially for a simulator flight under real conditions, charts are indispensable and give a lot of pleasure when using them.

FUEL CALCULATION

The Pilot in Command is obliged to inform himself about the route section and take sufficient fuel onboard the aircraft accordingly.

Simplified, the calculation is as follows:

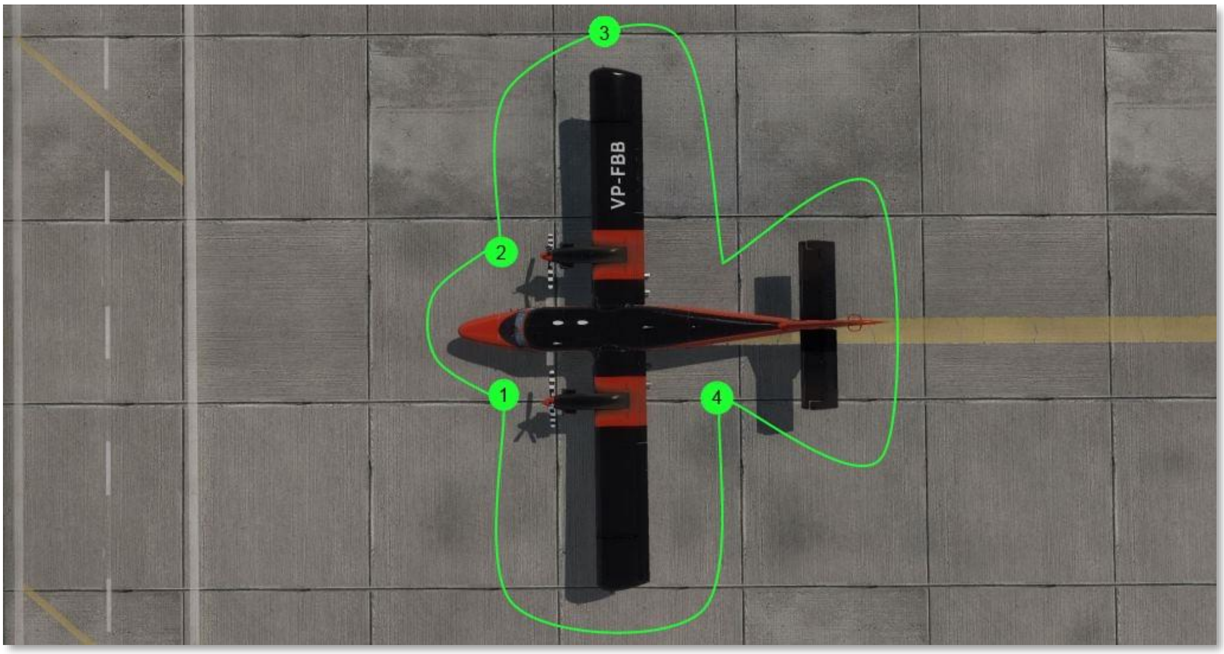
+ Taxi Fuel is the amount I need to get to the taxi stop of the runway.
+ **Route Fuel** is the amount used to get from take-off to 2,000 feet above the (Final) Destination.
+ **Approach Fuel** is the amount for a standard approach from 2,000 feet to a standard ILS with a 3° glide angle.
+ **Alternate Fuel** is the amount of fuel from the destination to the alternate airport.
+ **Final Reserve** is the amount to perform a holding pattern for 30 minutes.
= Required Fuel is the minimum amount required by law from the sum of the above fuel amounts.

This is the legally required quantity, which must not be fallen short of. If the calculation does not fit for reasons of payload (passengers, suitcases, cargo), a stopover with refuelling must be scheduled.

Twin Otters are very versatile, as you will have learned by now. But they are mostly flown on short to even very short routes these days. So while the simulator will prefer a default fuel load of 60%, most Twin Otter flights are done with much less fuel. If you load 25%, you can fly for over two hours, and as fuel is heavy, it makes a lot of difference in what you can carry, certainly if you are using floats and even more so when you are using the very heavy amphibian. Any pilot will tell you a light aircraft is happy, and the Twin Otter is no exception. So load the fuel that you need for the next flight plus an appropriate safety margin and not more.

WALK AROUND

The Pre-Flight Check is the check of the visual technical condition of the aircraft and is done through the walk-around. Although we know that you do not walk around your computers before the flight, we found this section interesting and briefly introduced the walk around. It is worth mentioning that nowadays, there are already aircraft add-ons that include a complete walk-around and even detect defects during the walk-around.



DHC-6 Walk Around

We divided the walk-around into four parts, marking the most important walk-around stations.

In the first phase (1), the left cockpit door is unlocked, and the covers of the static measuring points and pitot tubes are removed. The Ram Air inlet is checked to ensure no foreign objects are inside. Next, we look at the hydraulic unit flap; it must be tightly secured with two slotted screws. Some variants of the DHC 6 are equipped with optional oxygen equipment. Here we should check the level of the oxygen equipment and, of course, the condition of the oxygen masks. Further, the baggage compartment should be checked and locked.

The first step (2) is to check the tire pressure of all tires. The tires are usually filled with nitrogen to prevent the rims from rusting and avoid providing oxygen for a possible fire after hot brakes and tire blowouts. The pressure varies from model to model. Next, we check the strut; we look for leaks here. The front torque link and the connection pin is checked and secured. Moving on to the taxi light, we check the condition of the bulb and diffuser.

Moving on to Phase 3, the first thing we check is the nose of the Twin Otter. We check the surface for cracks to prevent possible water ingress. We continue with the walk around and unlock the right door of the DHC-6. Then the tire pressure on the right main landing gear is checked, and brake lines should also be checked for cracks and possible leaks. The fairing of the landing gear is also checked for cracks and damage, often these fairings suffer on rough runways, and stone chips are sometimes unavoidable.

The solid wing strut, which gives much of the wing stability, should be checked. Check is all rivets are still visible as a hard landing can shear the rivets. On the right side, the emergency exit window is also checked; it should be noted that it is secured and also protected from the inside with the plastic shell against unintentional operation. Furthermore, all other cabin windows are checked for cracks. Since the Twin Otter often operates on rocky and rough runways, objects can easily hit the underside of the fuselage, so all antennas should be checked.

Furthermore, the fuel drain valves can be found here. Here, a screwdriver and a collection container are used to drain the fuel. The kerosene is checked for contamination and water accumulation in a transparent container.

Continuing on the right-wing are the flaps, which can be fully extended for inspection. Caution is advised since objects, and upright doors can obstruct the flaps.

The right engine is inspected in detail. Among other things, the air intake is checked to make sure there are no loose objects inside. The oil dipstick is pulled out and should usually read around 2 quarts.

The propeller spinner should not have any damage or missing screws. The exhaust of the PT6 turbine must be free of objects. Since black exhaust on the engine is normal here, many Twin Otters are painted black in the engine and exhaust area. The cowling (fairing) must be tight, and the clips must all be in a closed position. On the engine, we also look for the fire discs, which are small viewing windows on the inside of the cowling. Here you can see if the fire extinguisher for the engine has been triggered. A red disc here indicates whether thermal expansion has occurred, i.e., whether the temperature of the fire extinguisher has reached 98 -104 degrees Celsius. A yellow disc indicates a standard manual release. Again, we have a fuel dump valve on the engine so that Jet A1 fuel can be removed, and the boost pumps must be activated for this.

The entire underside of the wing is checked, especially the rivets and leading edge of the wing. We check for any sign that could indicate a birdstrike. The landing light is switched on, and we check that the cover glass is not broken - the safety wire should also be in place.

The stall strip must be firmly glued to the wing's leading edge. Furthermore, we check the fuel vents and the fuse of the lightning strike system, as wasps like to build their nests here.

Continuing to the wing edge of the Otter, we take a close look at the navigation light. Check that the green glass is not cracked and check everything for functionality. At the wingtips, you will find so-called static wiggs; these are static discharge pins used to dissipate static energy. All pins should be in place, as an aircraft can be grounded during an inspection by the local aviation authority.

The ailerons should be undamaged and smooth-running, followed by a rudder and leading-edge check. You should also ensure that the de-icing strip is firmly glued to the surface. The horizontal stabilizer is then searched for dents and cracks; we also find the discharge pins; these must all be intact. We can see if the plane has touched down hard by checking the tail skid. Also, all the antennas must be in good condition with no corrosion. In the final step of this phase, we look to see if the rotating beacon is working and the elevator trim tab is clear.

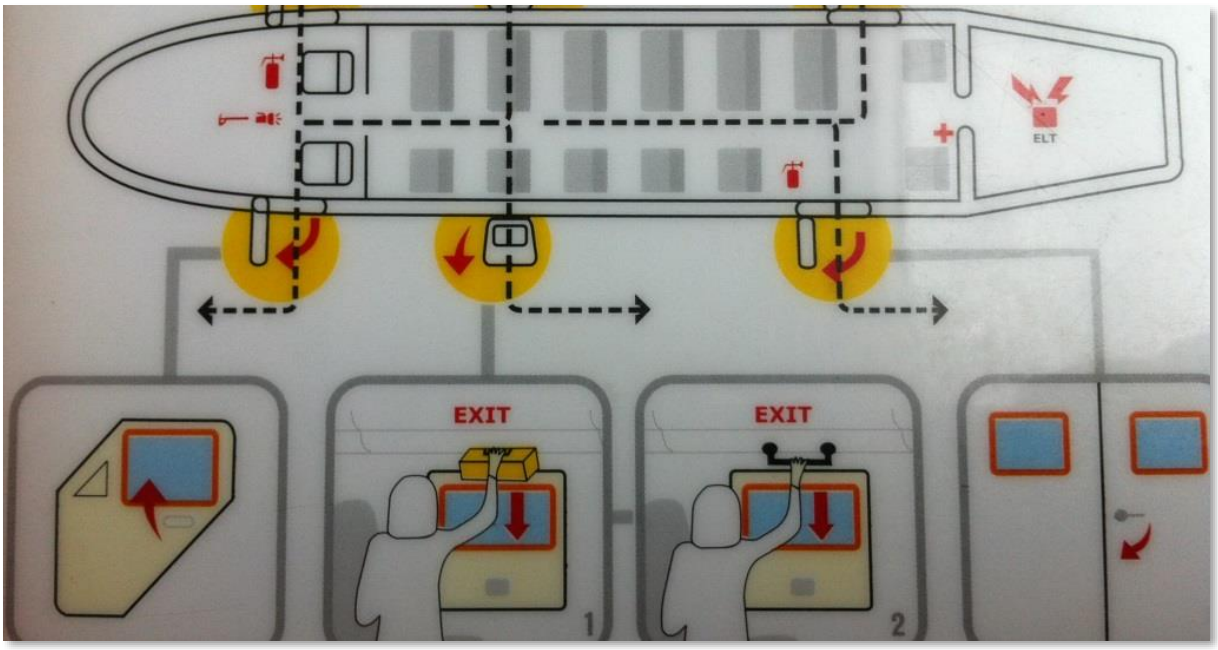
A rod is placed under the tail for safety to load the Twin Otter safety, called the Jury Strut. In Phase 4, we look to see if it is on board. When loading heavy cargo or when several passengers are staying in the rear area of the Twin Otter, the nose wheel lifts, and the aircraft can rest on the tail. The rear baggage compartment is secured and unlocked. When operating at higher altitudes, such as crossing the Alps, it is necessary to carry supplemental oxygen.

The Twin Otter is often started with a so-called GPU (Ground Power Unit) to protect the onboard batteries. This ground power unit provides the electrical power for the turboprop, and its output is 115V and 400 HZ, by the way. The unit can be connected to the airport's power grid or run autonomously with a diesel engine. During the walk-around, it is checked if the cable of the GPU is firmly connected to the socket.

On the left side, all checks are now processed as on the right side. In addition, the tank caps are checked, they must be tight, and the lock must be secured. With this action, we finish the exterior check or our walk around.

PAX BRIEFING

Before takeoff, the cockpit crew must ensure that the passengers have been informed about the smoking ban, seat belts, emergency exits, and life jackets.



EMER Card

The safety information usually looks like this - please note that we have omitted the note on what to do in the event of an emergency ditching:

"Good morning, ladies and gentlemen. Captain Krampitz and his co-pilot Aepfelbach would like to welcome you aboard flight 0420 from Bora Bora to Tahiti. Our flight time is predicted to be 50 minutes, and I would now like to ask you to fasten and tighten your seat belts. As always, we recommend that you keep your seat belt fastened throughout the flight for your safety. You are welcome to use your electronic device after takeoff when the seat belt signs above you have been turned off. Cell phones are not permitted aboard our aircraft, and we ask that they also turn off their cell phones completely at the latest. In the cabin of the Twin Otter, you will find two emergency exits, one on the front right and one on the left, in addition to the rear exits. You will find the details on the briefing card in the seat pocket in front of you. We wish you a pleasant flight."

PRE-START CHECKS

First, set the trim; the elevator trim pointer must be within the allowable range. The Take-Off Range can be seen here in the trim console viewing window. The rudder trim should also now be in the central position of the Take Off Index. We can check off this point after the aileron trim has also been moved to the neutral position. This check is critical as many accidents have happened here. The control surfaces of the Twin Otter are enormous and already show effect at low speeds, so it is important to trim the DHC-6 correctly before takeoff. But be careful; an improperly trimmed aircraft can, in the worst case, lead to a wrong angle of attack and, as a consequence, to a stall with a crash.

Now push the Prop Levers to Full Increase (MAX RPM); this is comparable to a passenger car in first gear. With the Prop Full Increase and Full Power setting, maximum climb performance is possible. At this point, the Autofeather switch above the artificial horizon is also activated. This safety system moves the propeller to the feathered position in the event of an engine failure so that no unnecessary drag is created.

The fuel quantity is rechecked and compared with the flight execution plan. We then set the tank selector switch to Normal, which means that both engines are supplied from their respective tanks, forward and aft. The flaps are set to 10° degrees, and in addition, the indicator on the centre spar is used to confirm that the flaps are at the desired position.

When the Twin Otter is on the runway and the aeroplane is stationary, the compass reading should be compared to the runway orientation. On runway 27, i.e., with an orientation at 270° degrees. The compass must read W as in WEST. Possible deviations due to magnetizing devices in the aircraft are usually not greater than 3° degrees.

The Bleed Air switch should be on if warm air is required in the cabin or de-icing equipment. If icing conditions are expected during or after take-off, the Anti-Ice must be turned on, such as the Propeller Heater or Intake Deflectors. In addition, the heated Pitot tube is also turned on at this point, as it counteracts ice buildup on the pitot tube. Ice accumulation can, for example, give false information to the Airspeed Indicator.

The altimeters are adjusted to the place altitude using the local pressure and are adjusted against each other; a deviation of more than 75 feet should be checked. Next, the rudders and control surfaces are checked for full deflection, pulling the yoke back and moving the aileron completely to the right and left. The rudder is also checked; this is done by stepping the rudder completely to the right and left. The last look goes over all flight instruments. No caution flags should be visible, nor should the artificial horizon hang to the right or left, but should be aligned with the correct horizon. We now check that all Caution Lights are out, but the Bleed Air light stays on if it is in the OFF position. If it is in the ON position, it will turn off as soon as the power levers are moved forward. Finally, the Anti-Coll or Strobe lights (if installed) are turned on.

CHECKLIST

In aviation, checklists are used to ensure flight safety. Before flight manoeuvres like take-off or landing, but also in case of incidents, the pilot controlling the aircraft works through the checklists to make sure that all settings are correct and nothing has been forgotten. For aircraft that only one pilot does not pilot (e.g., many commercial aircraft), the pilot not piloting (PNF/pilot not flying/pilot monitoring) reads the checklist and the pilot piloting (PF/pilot flying) works through the items. In emergencies (or all non-normal conditions), the PNF may also take over the execution of the checklist items, depending on the PF's current workload. Typical cases where checklists are used includes pre-flight checks and takeoff checks. [Source: Wikipedia]

In the simulator, the checklists also function as a workflow, and they also can do the action and not just check if it is done correctly. You can fully operate the Twin Otter just with the Microsoft Flight Simulator Checklists.

In the appendix of this book, you will find the currently valid checklist for the Twin Otter.

ENGINE START

Engine start is a complex topic that may have minor variations in checklists. Nevertheless, all lists point out that the Pilot in Command must always keep his hand on the fuel lever during fuel initiation until the start is completed. The possible dangers are a so-called hung start, i.e., too much fuel is injected, but the engine does not accelerate during the process. Thus, there is a risk of rapid overheating when the air-fuel mixture ignites.

ENGINE STARTUP SEQUENCE

The Pilot in Command considers the battery or external power voltage and the outside temperature and wind direction in the first phase. These factors have an influence on the T5 deflections during takeoff. After the prestart Checklist has been completed, the ground crew is advised which engine should be started first. Normally, this is the right one since the passenger door is on the left, and people can be evacuated quickly via the exit in the event of an engine fire directly during takeoff.

After pressing the start switch, the voltage indication is checked; normally, the indication only drops when the aircraft is on Battery Power - with External Power, there is usually no fluctuation. If the voltage drops below 17 volts, there is a possibility that the battery power is not sufficient to start the engines. The start should be aborted if the NG is insufficient and the self-preservation speed is not reached - about 50% NG.

After the NG and T5 readings have stabilized, fuel is added via the Fuel Lever. Normally, the NG reading settles at 16 to 18 per cent with a normally charged battery or around 23% with External Power. However, no fuel should be added if the NG value is below 12%.

Oil Pressure and T5 Gauge

In the event of a successful start, check the oil pressure, which should slowly increase.

The T5 indicator is checked until the light-off, the moment of ignition is seen about 10 seconds after added fuel. If no light-off is indicated, the fuel lever is pulled back to the OFF position, and the engine continues to run for another 10 seconds to empty the unburned fuel. After a successful light-off, the T5 and NG gauges will continue to be monitored; the NG gauge needle should rise steadily - a temperature spike can be seen after a short time as another seven fuel nozzles are added. However, once the second row of fuel nozzles begins injecting fuel, there will be fluctuations in the T5 reading between 30 to 40 per cent NG. Once the T5 reading drops and NG stabilizes at the preset value, the starting process can be considered complete. The Starter Switch will be released again when NG has stabilized, and the T5 is in the green range.

The starting process can be considered complete as soon as the T5 value drops, and NG stabilizes at the preset value. The Starter Switch will be released again when NG has stabilized, and the T5 is in the green range.

The generator light should now reappear on display, indicating that the starter button has been disabled.

The second engine is started in the same manner. A well-charged and maintained battery is capable of supporting both engines.

AFTER START CHECKS

Pilots must verify that both engines are operating properly and that the propellers are also operating correctly in the Forward and Reverse Thrust Range during the After Start and Pre-Taxi Check.

AFTER ENGINE START

After both engines have been started, the following actions are usually performed before continuing through the checklist:

The External/Battery switch is set to the Battery position. The cockpit crew then signals the ground crew that the ground power and brake pads can be removed. The Prop Levers are now pushed to MAX RPM - once the propellers stabilize at about 45% NP, the Power Levers are pushed to the IDLE NG plus 15% position. Optionally, the Generator Switches can be moved forward to RESET and then ON. Now check the generator load; pull the power levers back to IDLE as soon as it shows less than 0.5. The flaps are now set for take-off, and the Autofeather switch is activated. Once these actions have been performed, the After Start Checklist can be started.

AFTER START CHECKLIST

First, check the annunciator panel to see if the DOORS UNLOCKED light is off. After that, take a look at the lever position of the battery switch; it must be set to BATTERY at EXTERNAL/BATTERY. The GPU (Ground Power Unit), the external power connection, should be removed.

The pressure must be at 1300 to 1600 PSI for all hydraulic systems to operate smoothly. The brake wedges can now be removed, and the bleed air switches go to ON if heating in the cabin or deicing is desired.

Before taxiing off, the seat belts and buckles are checked. Now it's time to release the brakes. While the aircraft is stationary, you can check whether the nose wheel can be turned in the right direction and sufficient brake pedal pressure.

TAXI CHECKS

We now check the brakes as the Otter starts to roll gently. Here, a light press of the pedal is enough to check that the braking system is working properly. After that, our attention shifts to the instruments. The artificial horizon is particularly important here. No warning flags should be visible, nor should the horizon hang to the right or left. We find a button pulled out to balance the horizon on the horizon, if necessary.

All other devices are now checked. For example, the altimeter must show the altitude of the place after turning in the atmospheric pressure that is valid there. The navigation equipment must also be turned on and set to VOR or ADF. Next, the eye wanders over the engine instruments. By now, the engines should be at operating temperature and all instruments in the green range. The exact values can be found in chapter 4 in the table Engine Limitation.

Very important is the take-off briefing; here, you should give yourself or the crew member a short description of the take-off route and procedure in case of a technical problem after take-off. The exact flap position for take-off, the power setting, and the route to be flown must be determined. Pilots decide before takeoff what actions will be taken in the event of an engine failure or engine fire. Of course, the weather situation must be considered, as sometimes it is not advisable to return to the departure airport because meteorological conditions do not allow it due to overcast or fog.

Next comes the passenger announcement, which we all know from our vacation trips. At this point, passengers are informed about the duration of the flight, emergency exits, seat belts, and the use of telephones and electrical devices. And as we all know, very few listen - if you suddenly turn around at your home PC and shout into the room the safety instructions, you will only get shakes of the head (if at all). We speak from experience... Last but not least, the temperature of the batteries is checked; if the display is in the red area, the flight must be aborted. There is a risk of overheating or even explosion.

PRE TAKE-OFF CHECKS

First, in this section, we set the trim. It is important to accurately set the Twin Otter's trim to avoid a nasty surprise after take off. It is quite possible that an untrimmed aeroplane cannot be intercepted in time, and a stall will be the result. In the DHC-6, there is a sight window on each trim wheel where you can check the pointer position. This must always be set within the Take Off range.

The propellers are set to Full Increase, so full power and maximum RPM is available. To do this, the Prop Auto Feather switch is turned on, the system now has the status ARM but is not yet active.

The fuel quantity is checked again at this point; there must be sufficient fuel available for the entire flight. The fuel selector is set to NORM, which means that each engine is supplied from the corresponding tank.

The flaps are set to 10° degrees; this is cross-checked on display at the centre bridge between the front windows. The compass is used to check whether the compass direction is correct. This can be done with the runway alignment. In aviation, runway 18 means that the runway is oriented to the degrees of the compass rose and shows 180° degrees or south heading. This should also be indicated by the compass.

Next, the bleed air switches are flipped, but only if the deicing equipment or cabin heater is needed. The Intake Deflectors can be extended if icing should be present. Pitot Heat must be turned on when temperatures are less than +5° degrees, and moisture is visible. The altimeters are then set to place altitude using local pressure.

The control horn is now checked for free movement, which means that it is pulled back and turned to the right and left. The rudder pedals must also be depressed to full travel.

Now all important instruments like the oil pressure or the oil temperature are checked. All warning lights must now be extinguished, except for the Pneumatic Press light. This remains on if the bleed air is not switched on. However, if the bleed air is in the ON position, the light will go out as soon as the power levers are pushed forward.

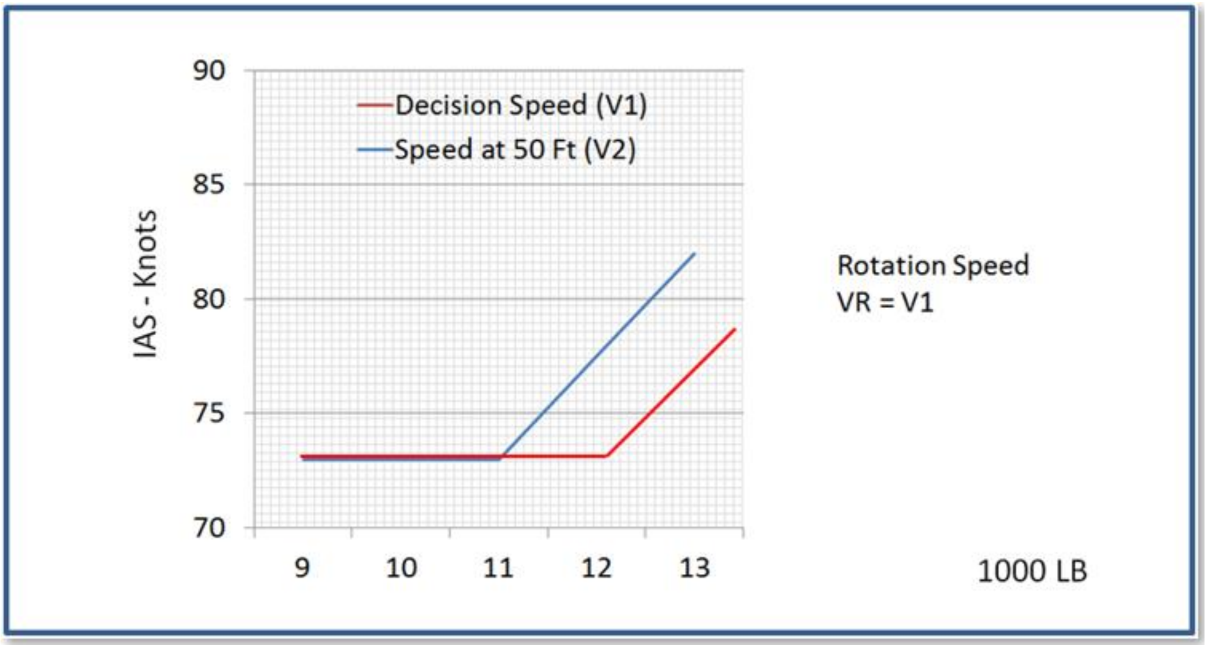
The pilots now switch on the anti-collision light and release the parking brake. The last thing to do is briefly look at the battery temperature indicator light, as it must not show more than 150° degrees. Now all pre-take-off checks are done, and we can finally take off.

We hear from Michael Awaii, who works for Win Air, that a take-off can sometimes be delayed. The captain had flown his Twin Otter to the island of Saba, 23 nm southwest of St. Maarten, to pick up passengers. Juancho E. Yrausquin Airport (TNCS) is famous for having one of the shortest commercial runways in the world.

Michael taxied back to runway 12 after collecting the tourists to turn around for takeoff. After the turn, the cockpit crew had 1,200 feet of runway at their disposal with no open space to avoid. Before setting takeoff power, the captain noticed a large crab on the runway and did not want to squash the arthropod. The pilots gave thrust, and the Twin Otter picked up speed; at the crab's height, it turned and waved its claws as if to thank them for their consideration. Certainly, an unusual experience can happen in regions like the Caribbean Sea.

CALCULATION TAKE-OFF SPEED

The take-off speeds depend on the take-off weight of the Twin Otter. The goal is to reach the 80 knots mark at an altitude of 50 feet. The rotation speeds must be taken from the table Rotation Speeds SFAR 23.



Rotation Speeds

This means that, for example, a weight of 12,000 LBS must be rotated at about 72 knots to reach 80 knots at an altitude of 50 feet. The 80-knot speed is maintained until a height of 400 feet, at which point the flaps can be retracted.

CRUISE

When cruising, we need to ensure that the higher we climb in percentage terms, the less power we have to retract the power levers. The turbine temperature (T5) must not exceed 725 degrees. Less air mass enters the turbine as the air becomes thinner with altitude. This has the effect that the combustion chamber is no longer cooled sufficiently, and the degrees slowly rise. By pulling back the thrust levers, less fuel enters the combustion chamber. We also reduce the propeller speed to achieve a larger angle of attack.

PRE-LAND CHECKS

Before landing, we also have to get out the checklists again and check or work through the following points. The Fuel Selector must be set to NORM, and all Boost Pump warning lights on the panel must be off. The Wing Tank switches must be set to OFF since the approach must not be made with the Wing Tanks. There is a risk that not enough fuel may be delivered.

Check the hydraulic pressure gauge to see enough pressure for the entire system, and the brakes are available. The nose wheel control must be centred, and the pointers must be aligned with the red marks on the control horn. The approach speed for all weights at or below 12,300 LBS is about 94 KIAS at flaps 10° degrees and about 85 KIAS at flaps 10° degrees. As described, the Autofeather system is not activated during landing.

APPROACH TO LAND

The flaps are now extended; the first flap stage can be run at 103 KIAS. The prop levers are pushed to full INCREASE, i.e., fully forward. Typically, these are set at 500 feet above terrain or the minimum for instrument approaches.

On the final approach for normal operations, flaps are set at 20° degrees. A typical approach speed at 11,500 LBS weight is 77 KIAS. When the Twin Otter has crossed the threshold at 50 feet, the power levers are pulled to idle.

Landing is always on the main landing gear. After the ride has been reduced, the nose wheel can be lowered. Once all wheels have made contact with the ground, braking can be applied if necessary.

The NWS (Nose Wheel Steering) must not be used until the Twin Otter slows to taxi speed.

AFTER LAND

After landing, first, retract the flaps. Next, turn off unnecessary electrical loads such as strobe lights, pitot heat, or landing lights. The de-icing equipment can also be switched off now unless it is still needed for taxiing, and there is a need to de-ice the leading edges of the wings until the Twin Otter is parked.

SPECIAL FEATURES SEAPLANE OPERATIONS

The handling of a seaplane is complex and requires some practice. To make it easier for virtual pilots to get started, we would like to give some additional information before the example flight to the Maldives.

Even experienced pilots can mess up a landing, as in the following example. We don't know if the two pilots are still flying in the Maldives.

A Twin Otter on floats suffered major damage during a training flight in the Maldives. Several flight configurations were simulated in Biyaadhoo Lagoon for an annual check flight. Except for the last training session, all takeoffs and landings were made inside this lagoon. The last manoeuvre has been done outside the lagoon in the open sea. The pilots practised landing with one engine and a strong tailwind. In the accident report, the crew later stated that the touchdown of the Twin Otter was initially very gentle, but they then collided with a wave and then bounced another 20 feet or so into the air. The ensuing impact was so extreme that the floats were completely bent upward and even touched the propeller tips. Also broken were the connecting supports of the two floats. Investigations revealed that the flaps and the flap selector switch were set at 0° degrees.

EMERGENCY AND ABNORMAL PROCEDURES

An emergency is an event that requires immediate action by the flight crew to protect the aircraft and occupants from serious damage. On the other hand, an Abnormality is an event that also requires the pilots' attention due to the failure of a system or component to ensure a certain level of airworthiness so that the flight can continue or ultimately be landed.

The pilot must follow a specific procedure for each abnormal event for the Twin Otter. Usually, each air carrier has its own Emergency Checklist for each aircraft type. This ensures that pilots do not have to spend a long time leafing through the operations manual in an emergency situation but can recall the most important emergency procedures within a few seconds.

The emergency checklist for a DHC-6 contains six sections that give the crew quick reference and help in an emergency. The sections are divided into Engine, Propeller, Electrical, Fuel, Hydraulic and Miscellaneous.

EMERGENCIES

We will use a brief example to reproduce an elevator from the checklist with the Hydraulic subsection before going into some detail with examples.

DHC-6 Emergency Check List
Hydraulic System Failure

Electrical Motor Pump Failure

See loss of hydraulic pressure

Loss Of Hydraulic Pressure

HYD HAND PUMP	OPERATE

If hydraulic pressure can be maintained with hand pump:

HYD PUMP CIRCUIT BREAKER (Main Panel)	CHECK (DO NOT RESET IN FLIGHT)
HYD HAND PUMP	OPERATE
HYD PRESSURE	MAINTAIN ABOVE 1500 PSI

If hydraulic pressure cannot be maintained with hand pump:

HYD PUMP CIRCUIT BREAKER (Main Panel)	PULL, DO NOT RESET

PREPARE FOR:

Flapless landing,
Limited wheel braking, if the break system is pressurized,
Use of zero thrust or gentle reverse to stop the aircraft,
No nosewheel steering, and possible severe nosewheel shimmy.

FLAPLESS LANDING

Wheels	V_{APP}	-94 KIAS
	V_{REF}	-77-94 KIAS

(Avoid excessive nose up attitude on touch down)

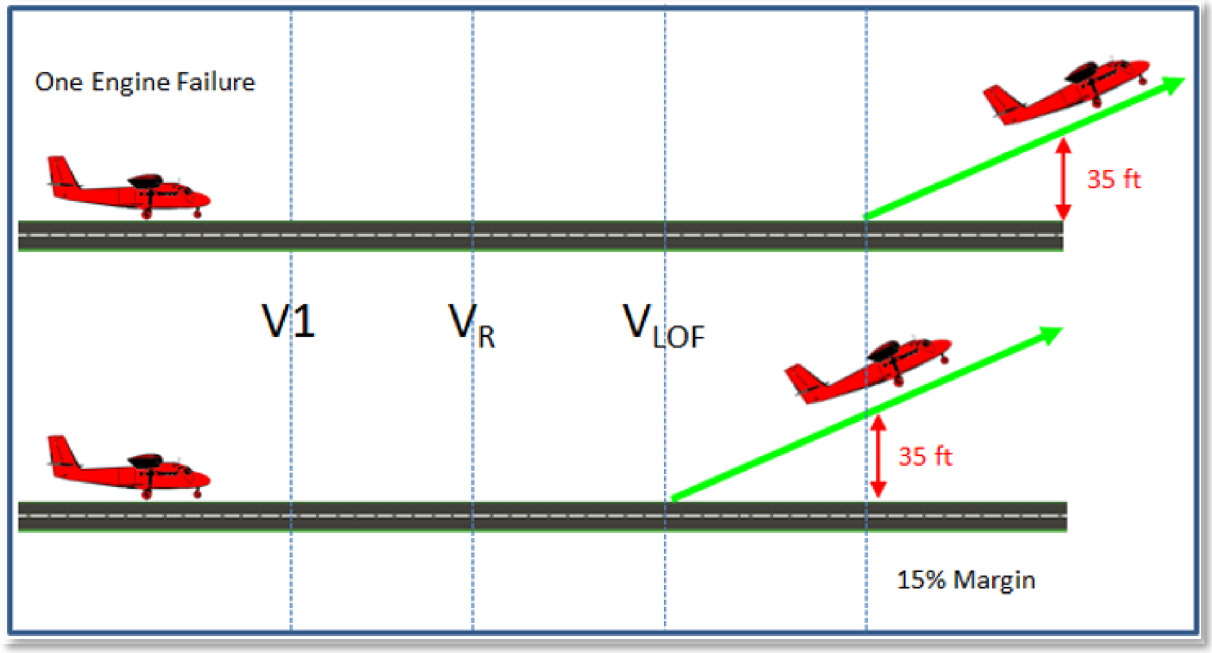
Emergency Checklist

It is easy to see the simple setup in the hydraulic system failure described here. Pilots immediately see in the instruction that they should use the hand pump to maintain pressure. If this is successful, there is a constant check that the pressure remains stable at 1500 PSI. If the cockpit crew cannot maintain pressure, they are given indications of what challenges await them during landing.

SINGLE ENGINE OPERATIONS

V1 is the decision speed, which means that before reaching V1, in case of failure, the Twin Otter will be slowed down, and after V1, it will be flown in any case. The calculated performance tables guarantee a minimum altitude of 35 feet at V2.

The Accelerate Stop Distance is the distance it takes to accelerate the Twin Otter to V1, then initiate a takeoff abort and come to a stop again by braking on the runway - but without reverse thrust, meaning only the brakes are used.



Engine Failure Take-off

The perfect performance during a flight with one engine is optimized if you tilt the aircraft with the aileron in the direction of the still-running engine. Here you should aim for about 5° degrees. The ball of the attitude indicator should be about one ball width from the centre, so the optimal rate of climb is reached and offers the best chance to get away from obstacles.

In cruise, the Twin Otter can be trimmed out again, in wings level and with the ball of the attitude indicator in the centre. Cruising speed will settle at about 105 to 120 knots. However, flaps must be set at 10° degrees if a climb is planned. Use of the autopilot is prohibited in single-engine operations below 105 knots.

ENGINE FAILURE

As described above, the Twin Otter can still be controlled quite well with one engine. However, in the event of a complete engine failure, other measures must be implemented to avoid endangering the safety of those on board as much as possible.

If an engine fails after take-off, after the After Take-off Checklist has been read and the Prop Autofeather Switch has been turned off, the following action is taken.

First, set maximum power on the still-running engine, ensuring that the T5 limit or the Ng limit is not exceeded. Ensure that the propeller levers are set to MAX RPM, i.e., 96% RPM. Now raise the nose slightly to maintain altitude. The heading of the Otter is controlled with the rudder.

The power lever is pulled back to the 10 PSI torque position on the defective engine, which is the zero thrust position. Now the propeller is moved to the feathered position so that it does not create drag. We move one lever further to the right and pull the affected engine's Fuel Lever (red lever) to the OFF position. Ensure that the correct fuel supply is interrupted.

Then trim out the Otter using the trim to counteract the yaw moment. It can also be flown with the flaps set at 10° degrees if necessary. At maximum take-off weight, the Otter can maintain an altitude of about 10,000 feet with the flaps retracted. If you wish to climb to another altitude and the airspeed drops below 103 KIAS, the flaps must be set to 10° degrees.

The boost pump of the defective engine is now switched off, and the DHC-6 should now be in a stable flight attitude. Next, we shut down everything unimportant to set the generator, the bleed air, and the Fuel Off Emergency Shut Off Switch to OFF.

Now we check if the generator load meter shows less than 1.0; otherwise, the electrical load must be reduced. For this measure, windshield heater, lights, radios, or strobe lights can be switched off.

In addition, care should be taken to regulate fuel consumption to maintain a balance if an immediate landing is not possible. Of course, landing at the nearest airport is advantageous, but possible maintenance or repair facilities locations should also be considered to avoid long downtimes of the Twin Otter. Of course, it makes no sense to land on the island of Lummerland if there is an airfield with maintenance personnel a few air miles away.

ICING

We have different icing scenarios in the flight phases, and icing can be expected at temperatures as low as +4 degrees Celsius and visible humidity. Limited visibility in an obviously dangerous temperature area is a good indication of icing, especially when the temperature is between -10° and +2° degrees. Thus, structural ice buildup that forms on the aircraft fuselage increases the weight and drag of the Twin Otter. Ice buildup can only be tolerated until flying in cruise is no longer possible. In this case, the de-icing boots must be activated immediately.

Ice buildup on the turbine air intake can cause a flameout (engine failure) under certain circumstances. Chunks of ice can flake off and enter the engine via the intake duct, where they can disrupt or damage the combustion process. This can be prevented by switching on the Inlet Heaters and extending the Intake Deflectors. These have already been explained in section 5.6.5.

The Pitot Heat is also switched on to prevent ice from accumulating on the pitot tube in colder climates. If the heater were not turned on, the pitot tube may drop to zero or not provide reliable information. By the way, this action is animated in the Twin Otter and can be tested by virtual pilots while flying in Antarctica.

Lastly, we mention propeller icing, where ice forms on the propeller blades. This reduces propeller performance, which can then cause the Twin Otter to become unbalanced and cause severe vibration.

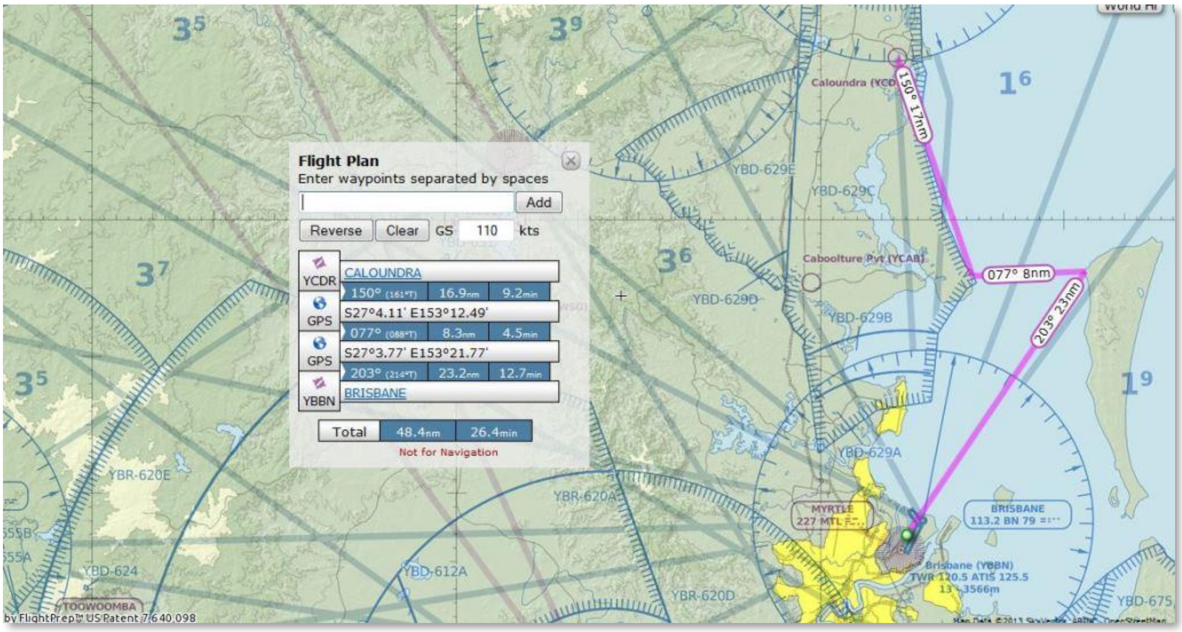
PRACTICAL PART

In the practical part, we have prepared two example flights in which we now put the theory learned above into practice. To the attentive reader, some points may seem duplicated - and rightly so; however, we put a lot of emphasis on demonstrating a realistic flight and applying the above-explained elements again. We will not go through the checklist in detail and only include the main points, such as engine start.

For all these flights, make your life easy, remove all weather and traffic.

EXAMPLE FLIGHT AUSTRALIA

On a beautiful spring day, Cpt. When they receive a training assignment, Krampitz and his co-pilot Aepfelbach are polishing the nose of the Solomons Twin Otter, which is parked at Caloundra Airport in Queensland, Australia. Today's sample flight will take us from Caloundra (YCDR) to Brisbane (YBBN), with a short detour over Moreton Island.



Routing, © skyvector.com 2014

We see our flight route from Caloundra via Moreton Island to Brisbane on the map. Caloundra is a smaller airport on the Sunshine Coast in Australia, mainly used by small private aircraft. The proximity to beautiful white beaches attracts many pilots to the coastal airport.

The flight route follows a southern course along with the rugged coastline. We see the monumental Glasshouse Mountains in the immediate vicinity, an inland chain of former volcanic cones. At the coast, we turn east to the offshore islands of Moreton island. This route keeps us out of Brisbane airspace until we get clearance to land there. Since our route is highly frequented and is often used by VFR pilots travelling north-south, we must keep our eyes open.

Over Moreton Island, we hope to get clearance from Brisbane Approach to land at Brisbane International Airport. To assist us, we will use the ILS to keep us on track with the localizer (landing course indicator) for runway 19. After landing, we will taxi to the GAT (General Aviation Terminal) area and drop off our passengers there. They will depart for a day trip to Surfers Paradise.

TAKEOFF

Before the engines are started, the following items should be completed:

The exterior check should be done, and the cockpit prepared for the flight. The cabin should be in a clean condition for the passengers, and it should also be checked that all seat belts and briefing cards are in place. Documentation, including all loading charts, should be on board.

Next, the passenger briefing is done and advised of any delays. After that, a look is taken at the hydraulic fuse. Often the technicians pull the hydraulic fuse for maintenance purposes. The fuel quantity must be checked and be sufficient for the flight. At the same time, the BOOST pumps are checked, no BOOST PUMP lights should appear on the caution panel. After that, the ANTI-COLL light comes on. Now the engines can be started.

ENGINE START

We now take care of the starting procedure of the Pratt&Whitney PT6A-27 turbine, which must have at least 24 volts charge for battery start and should be checked first on the voltmeter.

Voltmeter

Next, the START switch is operated, either LEFT or RIGHT as required. Normally, however, the right engine is started first so that evacuation is still possible in the event of an engine fire.

The absolute minimum for a successful engine start is 16% NG, i.e., 16% RPM of the gas turbine. If this speed cannot be reached, the start procedure must be aborted.

The gas generator should have stabilized, but an additional check must still be made to see whether the oil pressure rises. The fuel is injected through the FUEL Lever as soon as it is pushed forward to ON. We now wait for the light-up, i.e., the ignition of the kerosene-air mixture. The turbine accelerates up to 52% NG in a typical startup procedure. It is important to note that the turbine temperature T5 must not exceed its start limit of 1,090° degrees here.

The turbine has now reached its self-preservation speed, and the START button can be released. The generator lamp of the respective engine now lights up again. The oil pressure should be checked again; its minimum level is 40 PSI. The Prop Lever of the running engine is now pushed to Full Increase, and the Power Lever is set to Idle NG +15 %, i.e., about 70%. The generator is switched on, and the battery is charged for the second engine start. The battery charge can be checked by moving the spring-loaded voltmeter/battery gauge - the charge here should be 0.4 or less.

Now the generator of the running engine is switched off again, and the POWER LEVER can be brought back to IDLE. The second engine is now started as described above. Both generators are switched on after the second successful engine starts (idle +15% NG). The engine start is now completed.

CHECKLISTS

We take the After-Start Checklist and the Pre-Taxi Checklist, where the following items are worked through. First, the doors will be locked tight, and the DOORS UNLOCKED light will go off. The EXTERNAL/BATTERY switch will be in the BATTERY position; if external power has been used, it should be disconnected from the aircraft. Hydraulic pressure should ideally now be between 1,300-1,600 PSI. The chocks (brake pads) are now removed, and the bleedair switch goes to ON if cabin heating or deicing of the surfaces is required. The PROP LEVERS are then pushed to Full INCREASE.

The crew seats, seat belts, and shoulder harnesses are checked for proper fit. The parking brake is then deactivated. When taxiing away, make sure the nose wheel controls are working properly, the brakes are engaging, and the hydraulic pump electric motor pressurizes.

ROLL

After all, checks have been successful, the Twin Otter is now ready to roll. Before we start taxiing, we look at the Caloundra taxiing chart, and since the wind is at 110° degrees with 7 knots, we favour runway 12. To get to our destination, we taxi on runway 05 with a short backtrack to runway 30.

YCDR Airport

Since YCDR is an uncontrolled airfield, i.e., a CTAF (Common Traffic Advisory Frequency), the taxi must be announced by radio on frequency 118.8 MHZ. If necessary, own separation must be coordinated with other traffic in the airspace.

PREPARATIONS FOR TAKEOFF

We turn again to the taxi checklist and check the engine instruments. Oil pressure and temperature should be in the green range. The flight instruments are checked, the artificial horizon is adjusted to normal position, and the altimeter is set to the local altitude. The local QNH can be obtained from ATC Brisbane Centre 129.0 MHZ.

The Twin Otter is now aligned on runway 12, and the PRE-TAKE OFF checklist is worked through. After that, we set the trim, ensuring that the elevation trim pointer is selected in the forward range (FORWARD) if the CG of the load is in the aft range. If the centre of gravity is in the front, trim to the rear (UPPER). The propellers are pushed to Full Increase, the AUTO FEATHER Switch is activated, and the panel's light should now be illuminated.

Important: The fuel quantity should be sufficient for the flight, including all reserves. The fuel selector switch (Fuel Selector) goes to NORM for normal, which means that each engine is supplied by one tank. The flaps are now set to 10 degrees - check that the flap indicator really shows 10 degrees.

The compass should be aligned with the runway, so for runway 12 assigned to us, that means 120 degrees magnetic on the compass. The bleed air is turned on if warm air is needed in the cabin. However, in Caloundra, it is highly unlikely that Ice Protection will be used. In other climes with an outside temperature of less than +5 degrees and visible humidity, Pitot Heat (pitot tube heater) and the Intake Deflectors are run. The cabin temperatures are turned to the desired number of degrees. Then we set the altimeter to the place altitude of 38 feet

The control horn is moved in all directions to ensure it is clear and remove all fuses. The control surfaces must function over the entire range.

All thruster instruments are checked again; they should now be at operating temperature and appropriately in the green range. We look to see if all warnings (Caution) have gone out. However, if the Bleed Air Switch is OFF, the warning panel will show [Bleed Air]; the light will go out by pushing the Power Lever to full load. When the Bleed Air Switch is ON, no notice appears. We now turn on the Anti-Coll light - the aircraft is now ready for take-off.

TAKE-OFF

After communicating with other traffic on Caloundra on the CTAF frequency, the take-off can begin. To do this, we move the DHC-6 to runway 12 in YCDR and taxi forward a short distance to make sure the nose wheel control is centred. We stop and stand on the brakes, advancing the POWER LEVER to 85% NG. By pausing briefly for about 5 seconds, we allow the T5 temperature to stabilize; the delay allows the Compressor Bleed Valves to close. This procedure also builds sufficient airflow over the elevator and rudder until the brakes are released. This technique provides effective control of the rudder during the initial stages of takeoff. The NWS Tiller is not used here as it is too sensitive and has caused some accidents in the past.

The power levers are pushed forward smoothly, ensuring that the Autofeather system is activated. Especially on very short runs, where maximum performance is desired, stand on the brakes until the take-off power is reached. Only then should the brakes be released, as this procedure does not unnecessarily give away take-off distance.

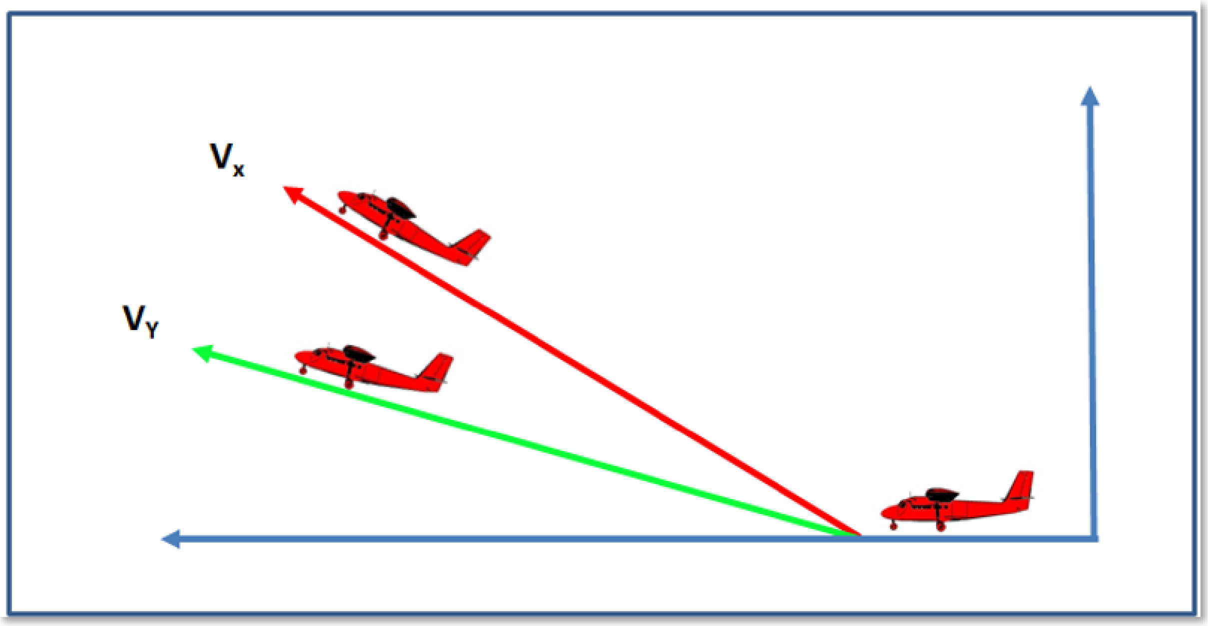
Caution: The so-called ram-air effect, to be precise, the aircraft's acceleration, will increase the torque. The power levers may have to be pulled back to not exceed the calculated power. Direction on the runway is controlled with rudder until rotation. Of course, rotation speed depends on weight and is calculated to reach a speed of 80 knots at 50 feet.

CLIMB

At 80 knots, we climb to 400 feet and then retract the flaps. The power levers are not retracted until the flaps are fully retracted. The speed can now be increased to 100 knots. This is now also the best rate of climb (Best Rate of Climb) or 87 knots for the best angle of climb (Best Angle of Climb).

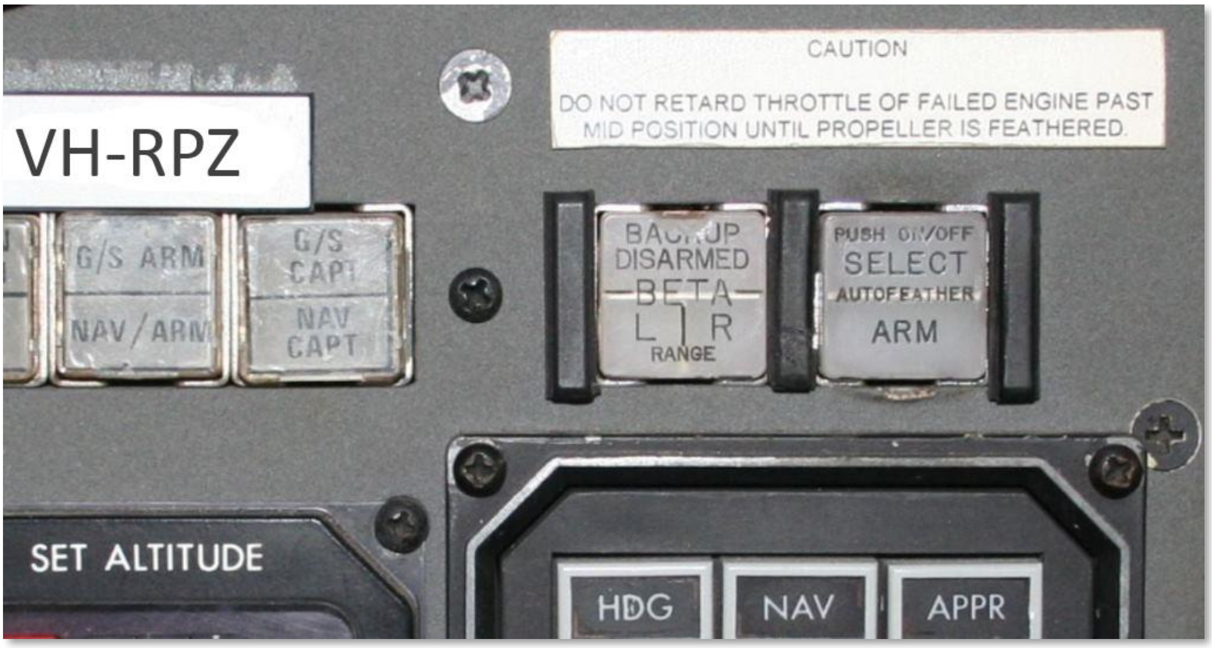
So we can say that the Twin Otter will not climb any steeper than it did with Vx. As a mnemonic, we have Vx, or you are Ex(it). So we try to get off the ground as fast as possible in the shortest time possible. After that, VY is more effective for the climb. Vx usually applies up to 1,500 feet AGL and is 1.3 times VS0.

We usually use Vx immediately after takeoff to fly over obstacles and then transition to VY to reach our cruising altitude.



Climb Rate vs Climb Speed

At a safe altitude, the setting of the power levers (power setting) can be changed. Furthermore, the Nosewheel Steering Tiller (NSW is checked. It should be centred; this can be seen by the markings on the control horn. The NO SMOKING and FASTEN SEAT BELT signs can now be turned off, the VENT FAN is turned off, and the PROP AUTOFEATHER switch is set to OFF.



Autofeather

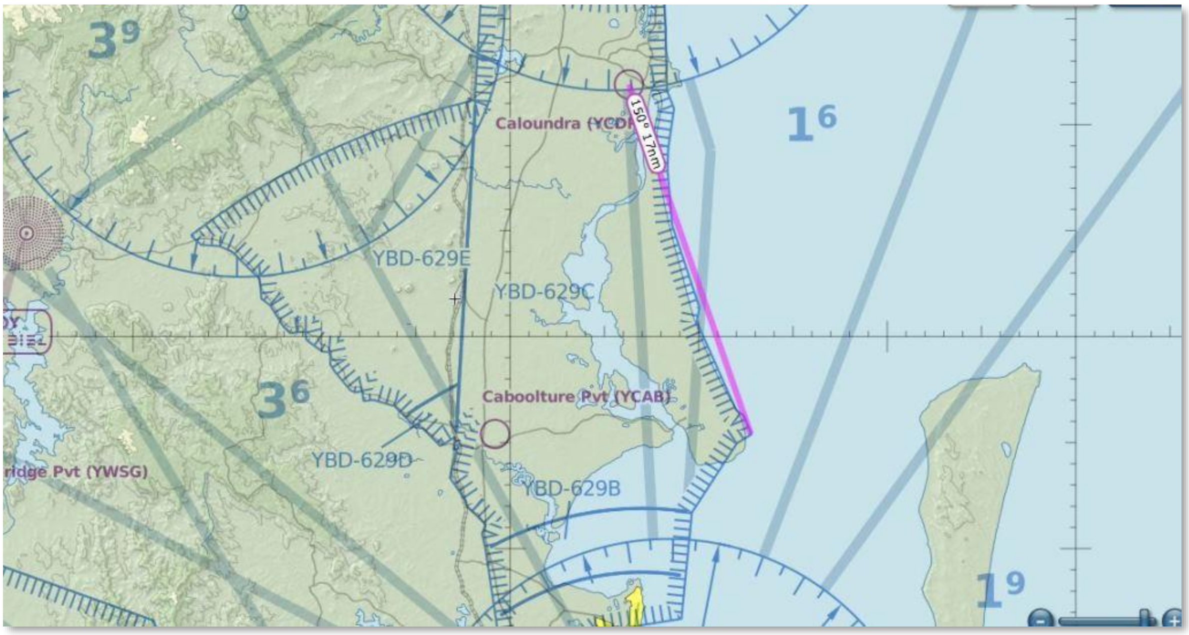
CRUISE

The aircraft is now in climb mode at approximately 1,000 feet. After the Twin Otter has accelerated, the cruise power setting can be set - in our case, 76% NP and 50 PSI torque. This involves returning the torque to about

45 PSI and pulling the prop levers to MIN, the mechanical stop. Any malingering of the thrusters can be synchronized by ear. The consumption of the engines at this altitude is about 350 Lbs per hour and engine.

If there is fuel in the wing(tip) tanks, this will be consumed first. The Twin Otter is now still in an extension of the runway heading. At 1,500 feet, we initiate the right turn and fly at 180 degrees (south heading) along the coast. Possible air traffic must be expected here, as we are on a famous "race track" for VFR pilots. Many pilots use this route to stay under the airspace of Brisbane International Airport.

We are still at 1,500 feet and flying along the coast. The co-pilot now switches to the Brisbane Information frequency.



Routing Part I, © skyvector.com 2014

We turn left and fly east (077 degrees) towards Moreton Island at the peninsula's tip. The co-pilot contacts Brisbane Information and requests a VFR landing at Brisbane International Airport. We are then handed over to Approach on frequency 124.7 MHZ. The approach may be rejected depending on the traffic density, as IFR flights and flights with so-called slots have priority. Fortunately, however, we get landing clearance.

Brisbane Approach assigns us as first a squawk code, a special code to identify our aircraft on the radar screen. The transponder code 4556 is turned in on the transponder.

The traffic situation allows the Twin Otter to land at Brisbane International. We are allowed to turn directly onto the extended approach baseline. We are allowed onto runway 19 at Brisbane International and now initiate a right turn onto this very runway. At this time, we are on the approach frequency.

Routing Part II, © skyvector.com 2014

The ATIS we intercepted is as follows:

Information Bravo ILS RWY 19 Wind 170/11, 10 km Sct 3200 25, 24 QNH 1017.

So this means that Runway 19 is being used, the wind is coming from the direction of 170 degrees at 11 knots, the visibility is 10 kilometres or more, the cloud base is at 3200 feet (scattered clouds), the temperature is 25 degrees, the dew point is 24 degrees, and finally the pressure is 1017 HPA.

We are using the ILS (Instrument Landing System) for navigational assistance. The frequency for Runway 19 is 110.10 MHZ.

As a reminder, the digression to the classic HSI: The HSI provides a bird's eye orientation for navigation. It gives heading, heading, and bearing information relative to a VOR, the ILS, and control points on runways or marker points.

The ILS is turned in on the HSI at 196° degrees and now presents glide path and landing heading on the instrument.

DESCENT

We are now in descent and looking at the Descent Checklist. Here the POWER is adjusted as needed, the FASTEN SEAT BELT sign is turned on, and the altimeter is set to the local QNH, in our case 1017.

Since we are at an altitude of only 1500 feet, we are sent straight to the extended approach line from this position - no further descent is necessary. Since it gets quite busy, the approach checklist should be read well in advance.

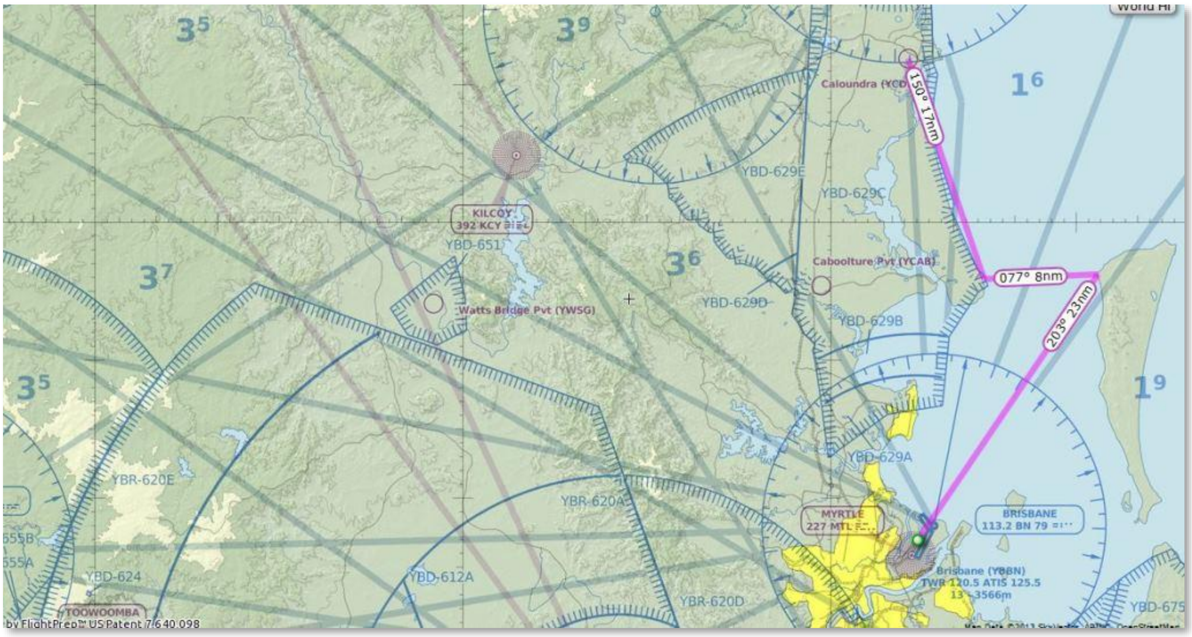
APPROACH

The Twin Otter is now on approach. The fuel selector goes to NORM, and we check if all boost pump lights are out. The wing tank system is shut down for landing, and the hydraulics should now read 1600 PSI. We also briefly check the system and brake pressures. The control of the nose wheel must be centred; the pilot checks this using the markings which can be seen on the control horn.

The approach speed is calculated with VAPP. Since the runway in Brisbane is not critical with a length of 3,500 meters, we can also approach quickly. At YBBN, we are expected to approach high speed to avoid obstacles to the fast-approaching jets. So we can now do the following; either approach with flaps at 0° degrees and a speed of 94 KTS (for weights under 12,300 LBS) or extend the flaps to 10° degrees and reduce to 85 KTS. The auto feather system will not be activated for landing.

On approach to Runway 19, we suddenly notice that the AFT FUEL LOW LEVEL light comes on. This indicates that the aft tank level is now at 110 Lbs. The checklist is immediately pulled from the side door pocket, and the emergency is worked through.

First, the Fuel Selector is switched to the other tank, the front tank. There are now 300 Lbs of fuel left - enough to continue the flight safely.



Routing Part III, © skyvector.com 2014

Three lights are now visible on the annunciator panel, the AFT FUEL LOW level light, and the two BOOST PUMPS of the AFT tank. The approach can now be safely continued. Should this occur in the cruise, consider using the fuel from the wings (if available).

LANDING

In the following table, the approach speeds for the respective weights are calculated. Each weight needs a minimum lift speed called Vs (Velocity Steady). This velocity is multiplied by a factor of 1.3 (Safety margin). The safety margin is used to avoid flying directly at stall speed. Due to wind changes such as gusts, it can happen that the necessary inflow is not directly at right angles to the wing surface but is slightly offset. This could then lead to a stall.

Flap Angle	Vs KIAS					
	12.300 LB	11.500 LB	10.500 LB	9.500 LN	8.500 LB	7.500 LB
20,0°	80	77	73	70	66	62
37,5°	74	70	67	64	60	57

We now push the Prop Levers forward to Full Increase (NP 96%) and confirm that the Reset Prop light is off. Once we cross the runway at 50 feet, the Power Levers are pulled to IDLE. The landing will be on the main gear, the nose wheel will be loaded, and the brakes will be applied after the nosewheel is on the ground. As the runway is long enough, we will not need to apply reverse thrust.

Please note landings are done with 20% flaps.

AFTER LANDING

First, the flaps are retracted, and then we switch off the equipment that is no longer needed. These are usually the landing, strobe, or pitot heating. The de-icing system can also be deactivated unless heavy icing is still expected up to the parking position, and any chunks of ice can get into the engine intake.

EXAMPLE FLIGHT MALDIVES

The option to land on the water with the Twin Otter appeals to many virtual pilots. However, there are some essential things to consider with the float variant, which we would like to explain here based on a Maldives flight.

The Twin Otter is anchored at the dock of the TMA Seaplane Base. We have already called Male Ground on 121.6 MHz and transmitted our flight plan. As with our colleagues on land, we are advised to vacate the runway as soon as possible after landing and keep sufficient distance from the water runways during the taxi.

PREFLIGHT

The preflight inspection of a seaplane is very similar to that of a landplane, but there are some exceptions. The biggest difference is the inspection of floats. The Airplane Flight Manual (AFM) or Pilot's Operating Handbook (POH) also includes procedures that must be followed in addition to the standard pre-flight checks.

The first step is for pilots to check that the floats are clear of the water and that the rear end of the floats is not too low in the water. If this is the case, the loading must be checked and preferably changed. In rare cases, the sinking of the floats may also indicate a hole and resulting water ingress. Afterwards, the floats are checked for visible damage such as crack marks, holes or corrosion.

Subsequently, the chambers of the floats are inspected for water accumulation, as this can also be attributed to a hole or condensation. Needless to say, any water found is completely removed, as it affects the Twin Otter's centre of gravity. In the case of larger amounts of water, the DHC-6 remains on the ground and must first be inspected more closely by technicians.

If the Twin Otter on floats is in colder climates or the temperature is around freezing, the aircraft is scanned for ice formation, which can also be caused by splashing water during the takeoff or landing process.

Before operating a seaplane, it is essential to familiarize yourself with the current and future water and wind conditions, as these have a major impact on the aircraft. After all parts such as an anchor or paddles are moored, we check if flotation devices are available for all persons on board.

NOTES TO PASSENGERS

In contrast to an airliner, the chances of survival in an emergency ditching with the Twin Otter are considerably higher. For this very reason, our passengers are educated on a few vital points. Usually, after preflight and boarding of the passengers, the Passenger Briefing is conducted. An evacuation of the Twin Otter on Floats involves some difficulties compared to a land-based aircraft, so everyone on board should know the DHC-6's emergency exits. Of course, in a small turboprop, this is the job of the cockpit crew.

The passenger briefing is the same as for a landplane, but now there are special instructions for the case of an emergency ditching, which we would like to explain briefly here. Certainly, it is useful to have read the following procedure once and remember it in case of an emergency in the Maldives, when the fish are swimming around your nose, and you are still sitting in the Twin Otter with your seat belt fastened.

First, we ask passengers to locate the nearest emergency exit in relation to their right or left knee. If the exit is on the right in the Twin Otter's normal position, it will be if the aircraft has turned. No matter how disoriented you are after an accident, as long as you still have your seatbelt buckled, the relationship to the exit remains the same. This means that you should be familiar with your surroundings and, in the worst case, find the exit even with your eyes closed.

In the event of an emergency ditching, the Twin Otter may turn upside down. Therefore, it is important to stay calm and follow the recommendations below to escape the possibly sinking aircraft.

1. Stay calm and think about what to do next. First, of course, wait until the plane has come to a complete stop - especially if it should turn underwater.
2. Reach for the life jacket. If time permits, put it on and inflate it only after abandoning the Twin Otter.
3. When sitting next to an emergency exit, do not open the door until there is enough water inside so that the pressure from outside is not too great.
4. Do not unbuckle the seat belt until the emergency exit is open. Hold on to sturdy things in the passenger compartment.
5. Move in the direction of the next emergency exit. If it is blocked, immediately find the nearest alternative exit. Always hold on to a stable part of the Twin Otter before taking the next step. Now step through the exit, but hold on until you make it outside. Stay calm once you exit the plane. Don't kick your legs because there could be someone behind you. If you get caught in something, like cables or debris, turn 90 degrees to get free.
6. Once you have left the Twin Otter on Floats and it is underwater, follow the bubbles to the surface of the water. If this is not possible, you can inflate the life jacket and float to the surface. Important: Breathe out slowly as you ascend.
7. Now inflate your life jacket completely. Make sure you are far enough away from the aircraft, and there is no danger of getting tangled with the rest or possibly blocking the entrance so that no passenger can get out.

CHECKLISTS

The checklists for the DHC-6 on floats are similar to that of a land aircraft. Our virtual checklist distinguishes between the different versions when working through the items.

ENGINE START

Compared to a seaplane, the launch preparations on the water are somewhat different. Usually, the Twin Otter floats is pushed away from the dock before the engine starts, and even the pilot often does this himself. Therefore, the pilot should work through the checklist as much as possible before pushing the aircraft away. In the Maldives, however, we saw that engine start was done right at the dock and, in addition, a flight attendant can assist the cockpit crew. Nevertheless, we want to describe the first variant, knowing full well that our readers will not get up from their PCs and run around the office chair once. Now then, when the DHC-6 is ready for takeoff, the pilot exits the cockpit, pushes the aircraft off the dock, re-enters the aircraft and quickly turns on the master switch. After that, the normal engine start begins as soon as the area around the propellers is clear of obstructions. However, one important difference is the launch locks installed in the float version. As already described, they prevent the Twin Otter from floating forward. If the Start Locks are active, this is indicated by the illuminated Beta Range light. If the Power Levers are pushed forward, no thrust is produced and therefore, there is little or no torque. Since the Start Locks hold the controllable pitch propeller at 0° degrees or less, the Power Levers must be pulled into Reverse Range to disengage the Start Lock.

TAXI INFORMATION

One of the biggest differences between using a Twin Otter on floats and a land version is manoeuvring the aircraft on the surface. The Twin Otter on land will generally remain motionless on the ground when the engines are in the IDLE position, especially with the parking brake set. The seaplane, on the other hand, by virtue of being free to glide, will always be moving in one direction - aided by the wind, water flow, propeller thrust and mass. Since the Twin Otter on floats has no brakes, the pilot must familiarize himself with influences such as wind and water conditions. Furthermore, the cockpit crew must plan the procedure carefully and always act with foresight.

We have been assigned the runway NBR (Northbound Right). This means we have to swim a short distance across a water taxiway. Seaplanes are only allowed to taxi on the west side before takeoff or landing. The cockpit crew must always be alert and on the lookout for other DHC-6s, whether on approach, performing takeoff, or swimming. Usually, drift is not a big problem, but still, we move forward slowly so that the floats in the water do not undercut and we can stop at any time.

TAXI AND START PREPARATIONS

Once we are number one in the starting order and ready for a speedy take-off, we call Male Tower on 118.1 MHz and ask permission to take off. It will sound like this: “Male Tower, 8Q-TMJ, on holding point runway NBR, ready for departure.”

Due to the rotation of the propellers, the Twin Otter drifts slightly, and the pilot should look for a fixed point on the horizon of the water runway, which he tries to steer to using the rudder to keep the difference between line and distance as small as possible.

We now cast off and move to the take-off position while adjusting speed to the wave situation. The Twin Otter should be steered with asymmetric thrust. Only flap positions from 0° to 20° degrees should be used during taxi.

We should be especially careful when manoeuvring here near the dock, as the DHC-6 on floats turns quickly into the wind, especially when the wind is coming from behind. Should this situation arise, we must respond immediately with reverse thrust. However, we must keep in mind that reverse thrust is only 30% available compared to forward thrust.

Since there is currently little airflow over the oil cooler, the oil temperatures must be closely monitored. We also keep a constant lookout for objects floating in the water. As soon as we have reached the take-off position, the Twin Otter must be turned into the wind.

TAKE-OFF

According to the manual, we start with the flap position of 20° and the maximum thrust to escape possible waves as fast as possible. The lift-off takes place at about 55 knots, whereby the minimum control speed (VMC) - i.e. the minimum speed at which the Twin Otter can be turned in the event of a failure - is set.

So now we push the prop levers completely forward and check that the torque is 50 lbs. Once we add thrust, we usually pause for two seconds at 85% NG and after the T5 indicator goes back a little bit to make sure the bleed valves are closed.

Now slowly push the Power Levers forward to the Calculated Take-Off Power Setting. The Autofeather ARM light should now come on, and as the speed increases, so should the Torque Pressure. The Power Levers are set to not go above the Calculated Take-Off Speed. With the pedals, we keep the direction.

As soon as the nose lifts slightly out of the water, we push the control column slightly forward to achieve the planned flight attitude. Once we reach an airspeed of 65 to 70 KIAS, we pull the control wheel back slightly and lift off the water.

The takeoff of a seaplane can be divided into four distinct phases. The so-called Displacement Phase, the Hump or Plowing Phase, the Planing or On The Step Phase, and the Lift-off Phase. We do not want to detail the phases; it is only important to know how the swimmers behave in the water. This means that the floats lie deep in the water during the first phase, controlling the Twin Otter. In contrast, only the rear part of the floats ploughs through the water during the ploughing phase - hence the floats become narrower towards the rear to ensure optimal separation of the aircraft from the water.

CLIMB

Shortly after the Twin Otter has left the water, the pilot accelerates the DHC-6 in the ground effect, i.e. a reduction of the downwind angle through the ground, which, simply put, produces a simpler lift. Incidentally, the ground effect occurs when the altitude is equal to or less than half the wingspan of the airfoil. After the co-pilot indicates that the speed of 70 knots has been reached, the flaps are retracted to 10°. However, the pilot does not transition to climb until a speed of 90 knots is reached. Many airlines climb with the prop levers set at 75%, as this procedure allows for a smooth climb.

We now reduce the Climb Power after we reach the altitude of 400 feet and retract the flaps fully. Torque should be at 50 lbs and NP at 85%. Now we work through the after takeoff checklist.

In the event of an engine failure, the cockpit crew climbs at 86 knots with the flaps at 10° because this is where they have the Best Rate of Climb (VY).

A small note: We do not reduce speed until the flaps are fully retracted.

CRUISE

Prop management for cruise is very similar to the climb phase. First, we reduce the power and prop levers, then adjust the Twin Otter for cruise. After reaching cruising altitude, the cruise power is set to 45 lbs torque and 76% NG.

DESCENT

The flight characteristics of seaplanes are comparable to those of land plants in the climb, cruise and descent phases. The only interference comes from the floats, as they have more drag than the landing gear configuration.

So we check various instruments, like the fuel selector switch or the fuel gauge. The cabin signs are turned on, and we briefly inform the passengers that we will be landing in a few minutes.

Should we perform an instrument approach, it is recommended that the pilot fly hands over control to the non-flying pilot while going through the approach briefing.

APPROACH

We are given the current weather information and landing direction from the tower, but we must satisfy ourselves that we will touch down safely on the water if we land near a hotel island (as we are now doing on this flight). Therefore we check the terrain during the approach and the wind direction, waves including their swell and the visibility conditions. Especially in the Maldives, we also look for obstacles above and below the water, such as corals, and select the optimal approach and landing area. It is advisable to make a circle around the landing area in question before landing to avoid any unpleasant surprises.

We now reduce our approach speed to 100 KIAS and extend the flaps to 10° degrees. It should be noted that the weight of our floats causes us to sink faster than a landplane. We now reduce speed to 95 KIAS while setting the flap lever one grid further to 20° degrees. We will then slow down until we reach about 85 KIAS. The Prop Levers are now pushed completely forward as soon as the flaps are either up or the RESET PROPS warning light comes on, but no later than when an altitude of 500 feet AGL has been reached for the visual approach.

LANDING

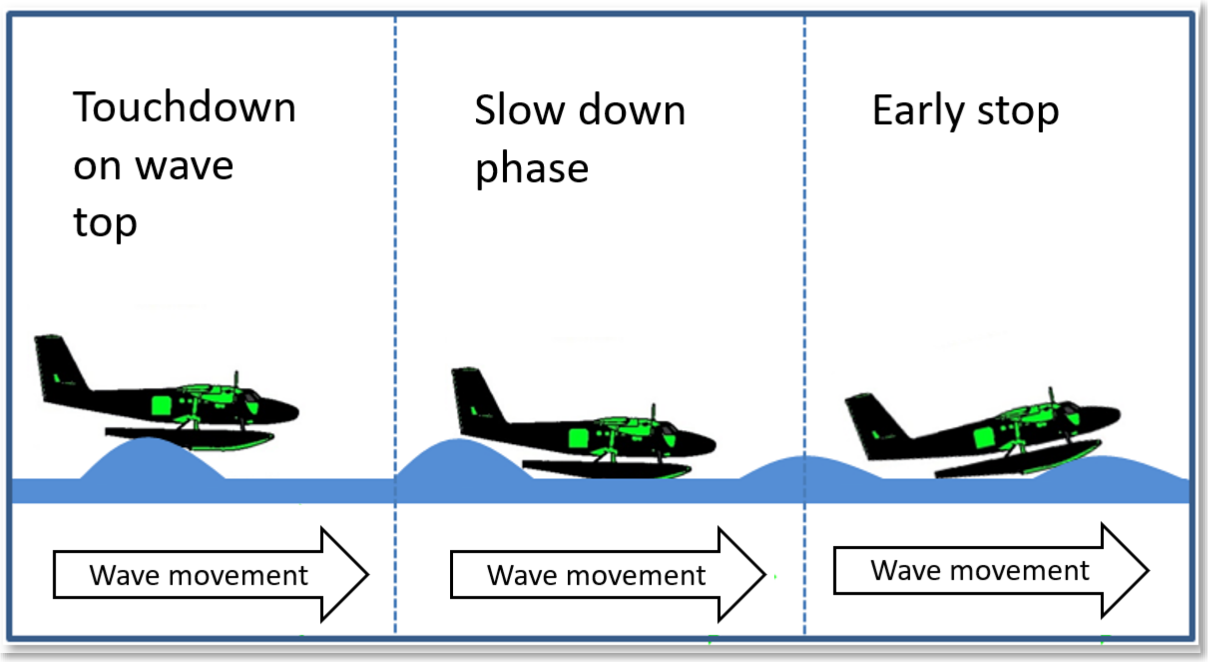
We are now close to landing; our Twin Otter has a maximum weight of 12,500 LBS and can land either with the flaps at 20° degrees and a speed of 80 to 85 KIAS or our case with flaps 37.5° degrees and 70 to 80 KIAS in case a very shott landing is required,. A configuration with retracted flaps is forbidden because not enough climbing ability can be guaranteed in an aborted landing. We adjust the sink rate using the power levers and set the flaps to 37.5° degrees as soon as a safe landing is guaranteed.

Use 20% flaps for landing; 40% is only used for very short landings.

We select a low sink rate with a low approach speed if the water has a rough surface, i.e. a high swell. We may need a torque of 10 PSI during the landing. We now use the rudder and yoke in the cockpit to somewhat control the drift caused by the crosswind so that the floats do not dip into the water during landing and the DHC-6 rolls over.

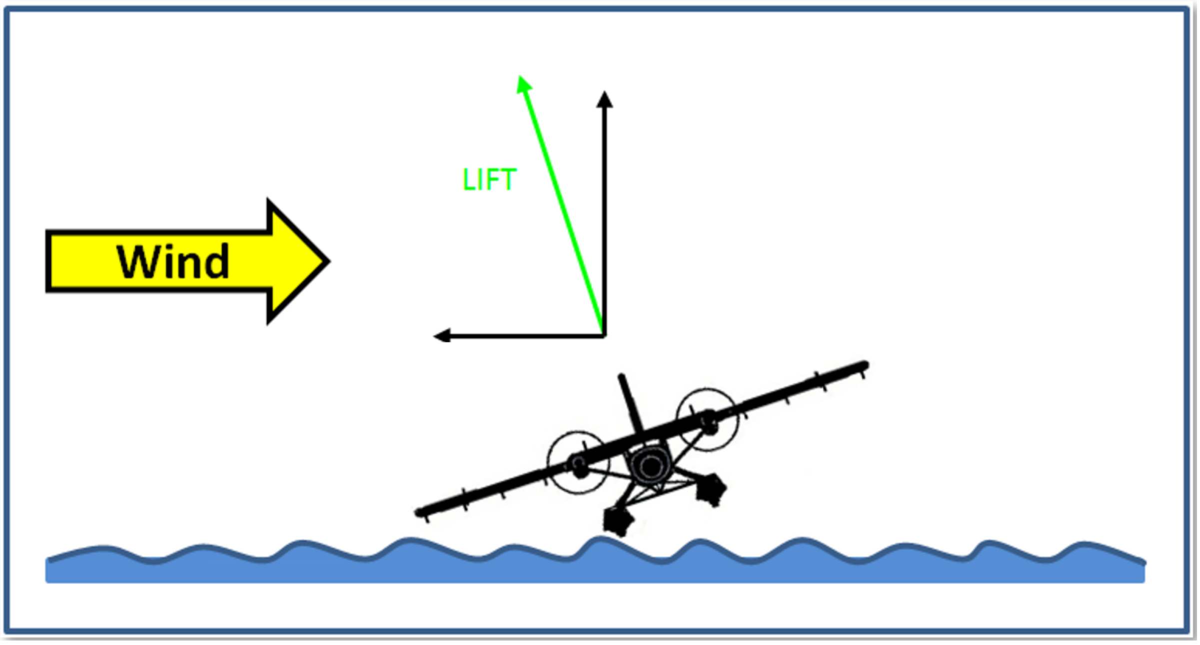
Just before touchdown, the power levers go into the IDLE position, and the nose of the Twin Otter is raised slightly. The control column continues to be pulled back slightly (HOLD AFT) as long as the Twin Otter's speed is reduced to Taxi Speed. We can now slow the Twin Otter down a bit with the reverse thrust if necessary.

We have now reached taxi speed and retracted the flaps completely; we now control the DHC-6 by using the differential power with the help of the power levers. If we give some thrust on the left engine, our aircraft will be steered to the right.



Waterlanding

Unfortunately, waves are not well animated in the simulator; nevertheless, we have included an illustrated digression for those interested. Pilots should consider a so-called down swell landing on the wave top; nevertheless, strong winds can make the landing run directly into the wave. In the image, you can see the floats of the DHC-6 directly after landing on the wave top; the aircraft then runs out together with the wave. Normally, after touchdown, the speed decreases to about 55 knots, and the Twin Otter can now use the wave motion as an unimpeded outrun until it is overtaken and slowed by the wave. This manoeuvre allows the aircraft to be stopped at a distance of fewer than 50 meters.



Crosswind Landing

A technique to compensate for the oncoming crosswind during water landings is similar to that used for land operations. The windward wing is lowered downward, keeping the heading straight by confirming the rudder pedals. This procedure produces a slip into the wind to compensate for aircraft drift.

On landing, the apparent water movement can be deceptive; the wave action makes it look like the water is moving sideways, but the water is stationary even though the wind is moving the waves. The waves are moving up and down on the surface of the water, so to speak. To detect the sideways movement of the sea and maintain a straight landing path, you should pick a point on the shore or a buoy. You now lower the windward wing just enough to prevent drifting and work the Rudder Pedals as mentioned above.

As soon as the DHC-6 on floats touches the water with the windward shimmer, its drag will quickly slow the seaplane, and the second float will dive into the water as soon as the aerodynamic lift decreases. The throttle is now retracted, and as the Otter slows down, more use is made of the aileron to keep the windward wing down. The Twin Otter is very unstable as it moves from the dipping phase to the ploughing phase - this means that the floats are now ploughing through the water. The turboprop should now be set into the wind, as the rudders are now less effective and the plane becomes increasingly difficult to control. Many pilots turn to the downwind side at this point until the aircraft is slow enough to transition to the taxi phase.

AFTER LANDING

After landing, there are several options to fix the Twin Otter at the final stopping point. Ramping has already been mentioned in 2.6.4 (Amphibian) and means that the aircraft can drive to the shore under its own power utilizing a ramp leading into the water. This process is, of course, only possible with amphibian aircraft. However, if the ramp has not been modelled well, the sim may detect a crash when the Twin Otter touches the ramp. Therefore we suggest switching off the crash detection in the flight simulator.

Three options are available for all seaplane-only operations. Beaching means pulling the DHC-6 on floats to a suitable beach. However, in the sim, this manoeuvre is quite difficult since the virtual pilot must land on the beach with engine power. It will be impossible to set down using the REVERSE if the Twin Otter has too much momentum here.

With the anchoring option, an anchor is attached to the aircraft's floats and lowered to the seabed, as with pure watercraft, with the premise that it digs into the subsoil and keeps the seaplane from drifting.

The last variation listed here is to fix the Twin Otter to a classic dock. This process is commonly practised in the Maldives - where the MAT and TMA turboprops are moored either at the Seaplane Base on the fixed dock or near the hotel islands on an admittedly somewhat shaky platform in the sea. Although there are now several seaplanes for the flight simulator, docking at the push of a button is unfortunately not yet possible. So, depending on the weather conditions, the aircraft drifts away from the dock or the platform again after docking.

PILOT REPORTS

We have a large network of Twin Otter pilots worldwide and follow their careers. Since the DHC-6 can be used in various locations worldwide, it is very exciting to hear the different reports and modes of operation. We have integrated some small stories into the course of the book, and we do not want to withhold a few remnants from you.

MALDIVES

We were told about an incident in the Maldives, where it became clear that water landings are significantly different from normal landings, especially regarding the safety zones around a runway.

A Twin Otter on floats from MAT was conducting a flight from Male to North Ari Atoll to take tourists to their resort. With winds gusting up to 20 knots and rough seas, the DHC-6 touched a wave with its floats and was catapulted back left into the air during the approach. The pilot immediately initiated a go-around and attempted to compensate for the left spin by turning right. Unfortunately, the Twin Otter struck a motorboat tied to the landing platform, causing the right float and engine to detach from the DHC-6. The pilot managed to land the aircraft on the left float, but when the speed was insufficient, the turboprop flipped to the right side and sank into the sea. All 14 passengers and the two crew members escaped without injury.

ANTARCTICA

Graham is an experienced Antarctic pilot who told us about a procedure he routinely performed after landing on an ice runway with his Twin Otter on Skies. To park the DHC-6 for the night, he placed some wooden slats and beamed parallel to each other in the snow and skied the Twin Otter right on top of them. This way, the skis were barely in contact with the snow and could not freeze overnight.

Alternatively, the wheels of the wheel-ski version can be hydraulically lowered to the parking position, and the Twin Otter is simply left on its wheels until the following day.

So there are quite a few interesting tricks pilots know to help themselves in the rough terrain. Personally, it was always an exciting moment when we were told a new story.

OCEANIA

Pilot Paul Anderson loves the Twin Otter with its short landing and take-off characteristics, providing faithful service for 30 years in remote areas of the world, such as communities in Papua New Guinea (PNG).

Paul can draw on vast and wide-ranging experience with the DHC-6. He shares this knowledge with many other pilots worldwide, especially his colleagues from Papua New Guinea (PNG), all of whom fly this wonderful aircraft.

PNG is a country of rugged beauty. It has varied landscapes, towering mountains, and a rapidly changing weather pattern. Sadly, many aircraft with pilots were lost in combat operations due to the terrain and weather.

The mountain range that stretches through PNG has summit elevations of over 14000 feet and is always a challenge, even for the Twin Otters. While many runways are an absolute no-go for some aviators, the workhorse DHC-6 is perfect for this. It can take off and land on almost any runway, such as sea level at 450 meters or difficult runways in the high mountains at 5000 feet with a 12% slope. As a rule, the runways are unimproved and in poor condition, with the rough, muddy surface.

The advantages of the Otter with approach speeds as low as 80 knots and the ability to manoeuvre in narrow valleys, i.e. turn on the spot over the wing, is unbeatable and has helped many pilots in dicey situations. Paul has thoroughly enjoyed his time in PNG as a Twin Otter captain and has always appreciated and respected the turboprop. It is a working machine that he has always trusted and has been a reliable companion. In parting, Paul says, "The next time you are on a big airliner, you can be sure that a pilot of the crew, in a remote part of this world, has gained great experience on the Twin Otter. So sit back, relax and enjoy the flight."

AFRICA AND THE TROPICS

Rob, a Twin Otter pilot in Africa, tells us about handling the turboprop in Africa. Especially when operating the DHC-6 in hot climates, such as Africa or the tropics, it is important to protect it from dust and sand and take precautions against humidity.

Rob explains the following steps he uses on his aircraft after landing. First, he tries to park the Otter in an area as free as possible from sand and/or dirt that may be stirred up by other aircraft. Particular care must be taken with the tanks to avoid contaminating the fuel. The engines and pitot tubes are usually covered when parking.

During loading and unloading, the Twin Otter is usually placed into the wind to keep the cabin as sand-free as possible The Intake Deflectors, which we also described earlier in this book, are placed in the extended position during engine takeoff and ground operations in the desert areas.

In the tropics, the aircraft is again subjected to special checks. For example, the fuel filters and fuel tanks are checked for condensate - this is usually done by a fuel check. The tires are checked for wear and existing air pressure. The Twin Otter is also checked for sand and debris. It is advisable to open the engine cowlings, i.e. the covers, and search the air ducts for sand before the engine start. Even small accumulations of sand can cause significant damage during takeoff.

APPENDIX

CHARTS AND DATA

DHC6-300 WHEELS PAX VARIANT

All tests completed in clear weather ISA conditions on DHC6-300 Wheels Pax variant

Aircraft weight 8200 lbs ~3720 kg

Maximum Cruise Power - 91% Np - 2000 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
0	50	166	380	760	tested at 100 feet above SL
2000	50	164	380	760	
4000	50	163	380	760	
6000	50	161	380	760	
8000	50	160	370	740	
10000	49	158	360	720	
12000	46	153	330	660	
14000	43	149	300	600	
16000	40	144	300	600	

Normal Cruise Power - 75 % Np - 1650 RPM

Pressure Altitude	Torque per eng	Airspeed	Fuel Flow per engine	total fuel flow	RMK
0	50	157	350	700	tested at 100 feet above SL
2000	50	155	340	680	
4000	50	153	330	660	
6000	50	151	320	640	
8000	50	150	320	640	
10000	50	149	320	640	
12000	50	147	320	640	
14000	50	145	320	640	
16000	48	140	320	640	

Economy cruise power - 75 % Np - 1650 RPM

Pressure Altitude	Torque per eng	airspeed	Fuel Flow per engine	total fuel flow	RMK
0	40	145	300	600	tested at 100 feet above SL
2000	40	144	290	580	
4000	40	142	280	560	
6000	40	141	270	540	
8000	40	140	260	520	
10000	40	139	260	520	
12000	40	137	240	480	
14000	40	135	240	480	
16000	40	134	260	520	

Aircraft weight 12500 lbs ~5670 kg

Maximum Cruise Power - 91% Np - 2000 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
0	50	165	380	760	tested at 100 feet above SL
2000	50	164	380	760	
4000	50	163	380	760	
6000	50	161	380	760	
8000	50	160	370	740	
10000	49	158	360	720	
12000	46	153	330	660	
14000	43	148	300	600	
16000	40	144	300	600	

Nomal Cruise Power - 75 % Np - 1650 RPM

Pressure Altitude	Torque per eng	Airspeed	Fuel Flow per engine	total fuel flow	RMK
0	50	156	340	680	tested at 100 feet above SL
2000	50	155	340	680	
4000	50	153	330	660	
6000	50	151	330	660	
8000	50	150	330	660	
10000	50	148	320	640	
12000	50	147	320	640	
14000	50	145	320	640	
16000	47	140	320	640	

Economy cruise power - 75 % Np - 1650 RPM

Pressure Altitude	Torque per eng	airspeed	Fuel Flow per engine	total fuel flow	RMK
0	40	145	300	600	tested at 100 feet above SL
2000	40	144	290	580	
4000	40	142	280	560	
6000	40	141	270	540	
8000	40	140	260	520	
10000	40	139	260	520	
12000	40	137	250	500	
14000	40	135	240	480	
16000	40	134	260	520	

DHC6-100 WHEELS PAX VARIANT

All tests completed in clear weather ISA conditions on DHC6-100 Wheels Pax variant

Aircraft weight 11600 lbs ~3357 kg

Maximum Cruise Power - 91% Np - 2000 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
0	42	154	380	760	tested at 100 feet above SL
2000	42	152	370	740	
4000	42	151	370	740	
6000	42	150	370	740	
8000	42	149	360	720	
10000	42	148	360	720	
12000	41	145	340	680	
14000	39	141	320	640	
16000	36	137	320	640	

Normal Cruise Power - 75 % Np - 1650 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
0	42	146	340	680	tested at 100 feet above SL
2000	42	145	330	660	
4000	42	144	320	640	
6000	42	143	320	640	
8000	42	141	320	640	
10000	42	140	320	640	
12000	42	138	320	640	
14000	42	136	320	640	
16000	40	133	320	640	

Economy cruise power - 75 % Np - 1650 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
0	35	137	300	600	tested at 100 feet above SL
2000	35	136	300	600	
4000	35	135	280	560	
6000	35	134	280	560	
8000	35	132	260	520	
10000	35	131	260	520	
12000	35	130	250	500	
14000	35	129	250	500	
16000	35	127	280	560	

Aircraft weight 11600 lbs ~5262 kg

Maximum Cruise Power - 91% Np - 2000 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
0	42	154	380	760	tested at 100 feet above SL
2000	42	152	380	760	
4000	42	151	380	760	
6000	42	150	370	740	
8000	42	149	370	740	
10000	42	148	360	720	
12000	41	145	340	680	
14000	39	141	320	640	
16000	36	136	320	640	

Normal Cruise Power - 75 % Np - 1650 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
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2000	42	145	330	660	
4000	42	144	320	640	
6000	42	143	320	640	
8000	42	141	320	640	
10000	42	140	320	640	
12000	42	138	320	640	
14000	42	136	320	640	

16000	40	132	320	640

Economy cruise power - 75 % Np - 1650 RPM

Pressure Altitude (ft.)	Torque per eng (p.s.i)	Airspeed IAS (KTS)	Fuel Flow per engine (lbs/hr)	total fuel flow (lbs/hr)	RMK
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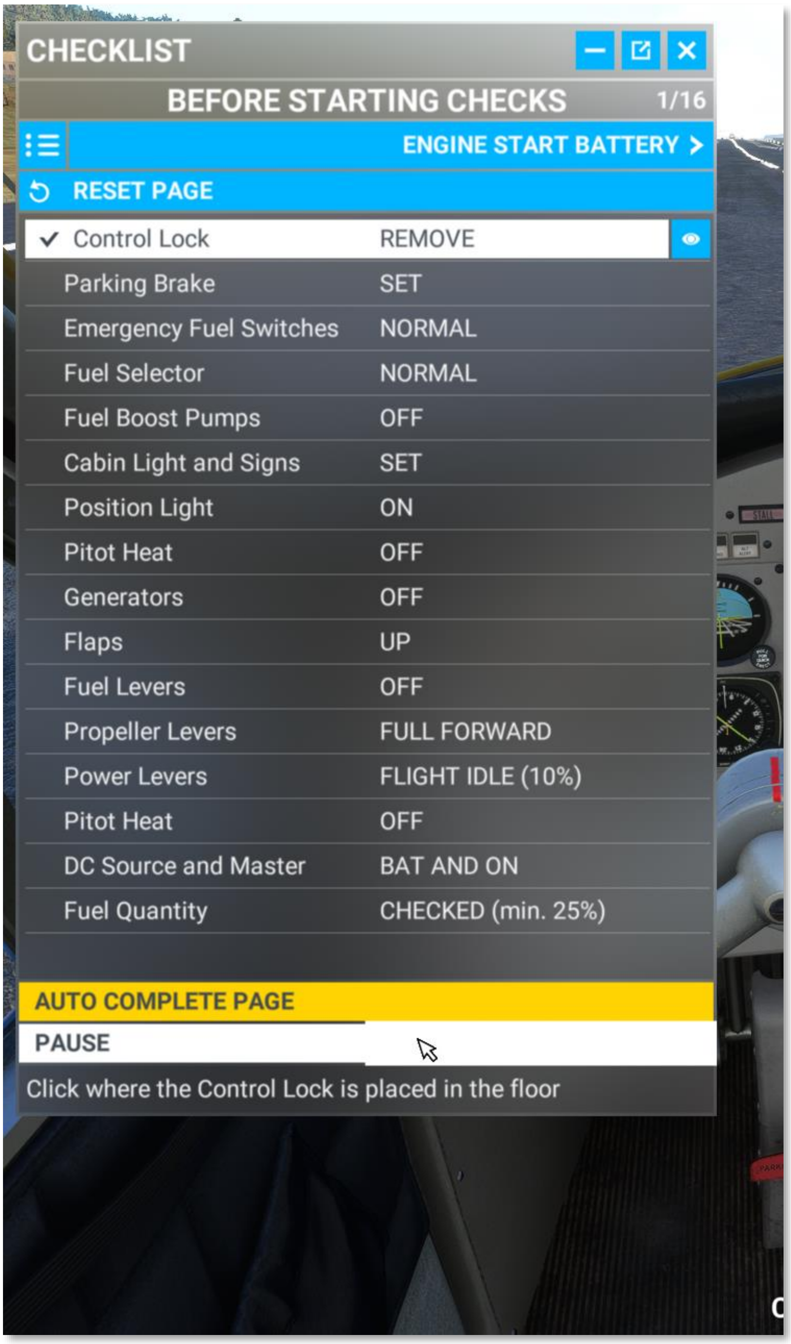
4000	35	135	280	560	
6000	35	134	280	560	
8000	35	132	270	540	
10000	35	131	260	520	
12000	35	130	250	500	
14000	35	129	250	500	
16000	35	127	280	560	

CHECKLISTS

There are three checklists available.

1. The Checklist inside the simulator. This one is identical to the ‚short‘ checklist. In the simulator, the system can perform all the items on the checklist, so you can start the system with just a few clicks.
2. The short checklists. This one can be used for every flight
3. The extended checklist. This one is intended for the day's first flight and contains many more items. Do not expect each of these to be fully modelled in the simulator.



SHORT CHECKLIST

BEFORE STARTING CHECK

Parking brake	SET
Emergency fuel switches	NORMAL
Fuel selector	NORMAL
Fuel boost pumps	OFF
Radio switches	BOTH OFF
Cabin light and signs	SET
Beacon light	ON
Pitot heat	OFF
Generator switches	OFF
Flaps	UP
Fuel levers	OFF
Propeller levers	FULL FORWARD
Power levers (10% fwrd.)	FLIGHT IDLE
Ignition switch	NORMAL
Battery master	ON
Fuel quantity	CHECKED

ENGINE START BATTERY

Right engine to be started:

Boost pumps	ON
Start switch	ENGAGE
Oil pressure	CHECK RISING
Ng	CHECK STABLE
Fuel levers	ON (FULL FWD)
T5 and Ng gauge	MONITOR
Engine start switch	CENTER POS

Repeat for left engine

AFTER START CHECKS

Power levers (15% fwrd)	IDLE
Generator	ON, LHT OUT
Engine instruments	WITHIN LIMITS
Radio switches	ON
Compass and Gyros	SET
Caution lights	APPROPRIATE
Altimeters and clocks	SET
Anti Coll and position lights	ON

TAXI CHECKS

Brakes	CHECK
Gyros and turn needles	CHECKED

RUN-UP CHECKS

Parking brake	SET
Auto feather	ON/ARM
Anti ice	AS REQUIRED
Autopilot	CHECKED

RUN-UP CHECKS

Parking brake	SET
Auto feather	ON/ARM
Anti ice	AS REQUIRED
Autopilot	CHECKED

BEFORE TAKEOFF CHECKLIST

Fuel Quantity	CHECKED
Fuel Pumps	ON
Trim tabs	SET 10°
Flight instruments	CHECKED
NAV / COM radios	SET
Propeller levers	FULL FORWARD
Auto feather	ON (LIGHT ON)
Flaps	SET 10-20
Engine instruments	CHECKED
Pitot heat	ON
Anti ice	AS REQUIRED
Flight controls	FREE
Transponder	SET AND ON
Landing lights	ON
Caution lights	APPROPRIATE
Runway and heading	CHECKED

CLIMB CHECKS

Flaps	UP
Auto feather	OFF
Climb power	SET
Landing lights	OFF
Vy (best rate)	85 KTS

CRUISE CHECKS

Cruise power	SET

DESCENT CHECKS

Fuel quantity / selector	CHECKED
Caution lights	APPROPRIATE
Anti ice	AS REQUIRED
Altimeters	SET
Signs	SET
Landing lights	ON

AFTER LANDING

Flaps	UP
Anti ice	OFF
Landing lights	OFF
Transponder	OFF
All trim tabs	NEUTRAL
Anti Coll lights.	OFF

SHUTDOWN

Parking brake	SET
Power levers (10% fwrd)	FLIGHT IDLE
Propeller levers	FEATHERED
Generators	OFF
Fuel levers	OFF
Fuel boost pumps	OFF
All light switches	OFF
Battery master	OFF
Aircraft	SECURE

EXTENDED CHECKLIST

Pre-Start:

[ ] Control locks	Off
[ ] Parking brake	Set
[ ] Fire handle	In
[ ] Emergency fuel switches	Normal
[ ] Emergency pumps	Off
[ ] Fuel selector	Normal
[ ] Boost pumps	Off
[ ] Static source	Normal
[ ] Vent fan	Off
[ ] Inverter switch	Select 1 or 2
[ ] De-Icing switches	Off
[ ] Cabin lighting and signs	Set
[ ] Anti col light	On
[ ] Bleed air switches	Off
[ ] Pitot heat	Off
[ ] Generator switches	Off
[ ] Bus tie switch	Normal
[ ] Flap handle	Up
[ ] Fuel levers	Off
[ ] Propeller levers	Full forward / Feather
[ ] Power levers	Flight idle
[ ] Windshield heat/Wipers	Off
[ ] Landing lights	Off
[ ] Ignition switch	Normal
[ ] D.C master	On
[ ] External/Battery switch	Battery
[ ] Bus voltage	Checked (18V min)
[ ] Caution lights	Checked
[ ] Fire detection	Test
[ ] Fire bell mute	On then Off
[ ] Fuel quantity	Checked
[ ] Fuel quantity indicators	Checked

Crossfeed check:

[ ] Boost pumps	On
[ ] Fuel selector	Both on FWD
[ ] Boost pump 1 FWD press light:	Out
[ ] Boost pump 2 FWD press light:	Out
[ ] Boost pump 1 AFT press light:	On
[ ] Boost pump 2 AFT press light:	On
[ ]Fuel selector	Both on AFT
[ ] Boost pump 1 AFT press light:	Out
[ ] Boost pump 2 AFT press light:	Out
[ ] Boost pump 1 FWD press light:	On
[ ] Boost pump 2 FWD press light:	On
[ ] Boost pumps	Off
[ ] Fuel selector	Normal

Emergency pumps check:

[ ] Stdb boost pump Emer FWD	On
[ ] Boost pump 1 FWD:	On
[ ] Boost pump 2 FWD:	Out
[ ] Stdb boost pump Emer FW:	Off
[ ] Stdb boost pump Emer AFT:	On
[ ] Boost pump 1 AFT:	On
[ ] Boost pump 2 AFT:	Out
[ ] Stdb boost pump Emer AFT	Off

Boost pumps check:

[ ] Boost pump FWD:	Test
[ ] Boost pump 1 FWD press light:	On
[ ] Boost pump 2 FWD press light:	Out
[ ] Boost pumps AFT:	Test
[ ] Boost pump 1 AFT press light:	On
[ ] Boost pumps 2 AFT press light:	Out
[ ] Brake/Hyd. Pressure	Checked

Engine start:

[ ] Fuel levers	Off
[ ] Propeller levers	Full FWD/Feather
[ ] Power levers	Idle
[ ] Boost pump FWD/AFT	On
[ ] Start switch	Engine right
[ ] Fuel lever right	On (Ng>12%)
[ ] Propeller lever right	Full forward
[ ] Start switch	Engine left
[ ] Fuel lever left	On (Ng>12%)
[ ] Propeller lever left	Full forward
[ ] Generator left/right	On (Load below 0.5 Amps)

After engine start:

[ ] Compass and gyros	Check
[ ] Caution lights	Check
[ ] Altimeter and clocks	Set

Taxi checks:

[ ] Signs	As required
[ ] Brakes	Check
[ ] Nosewheel steering	Check
[ ] Gyros	Check

Run-up check:

[ ] Parking brake	Set

Propeller feather check:

[ ] Propeller levers	Retard to feather (Np appr at 23%)
[ ] PROP RESET light:	On
[ ] Propeller levers	Full forward

Beta range check:

[ ] Power levers	Retard to beta range
[ ] Beta range lights left & right:	On

Beta backup test:

[ ] Power levers	Idle
[ ] Propeller lever	Full forward
[ ] Power lever left	Retard to reverse
[ ] Beta range light left:	On
[ ] Beta range TEST switch	On
[ ] Beta range light left:	Check 2 cycles
[ ] Beta disarm light:	Check 2 cycles
[ ] Beta range TEST switch	Off
[ ] Power lever left	Idle
[ ] Power lever right	Retard to reverse
[ ] Beta range TEST switch	On
[ ] Beta range light right:	Check 2 cycles
[ ] Beta disarm light:	Check 2 cycles
[ ] Beta range TEST switch	Off
[ ] Power lever right	Idle

Propeller governor test:

[ ] Power levers	Idle
[ ] Propeller levers	Full forward
[ ] Propeller GOV Test switch	On
[ ] Power levers	Advance Np governs at appr. 70%
[ ] Propeller GOV Test switch	Off

Autofeather test:

[ ] Power levers	Idle
[ ] Propeller levers	Full forward
[ ] Auto feather	On
[ ] SELECT light:	On
[ ] Power levers	Advance to 25 PSI torque
[ ] Autofeather TEST switch	On
[ ] ARM light:	On
[ ] Power lever left	Idle (Left propeller feathers)
[ ] ARM light:	Out
[ ] Power lever right	Idle (Right propeller must NOT feather, Left propeller unfeathers
[ ] Power levers	Advance to 25 PSI torque
[ ] Autofeather TEST switch	On

[ ] ARM light:	On
[ ] Power lever right	Idle (Right propeller feathers)
[ ] ARM light:	Out
[ ] Power lever left	Idle (Left propeller must NOT feather, Right propeller unfeathers
[ ] Autofeather TEST switch	Off
[ ] Power lever left	Advance to 88% Ng
[ ] ARM light:	On
[ ] Power lever left	Idle
[ ] ARM light:	Out
[ ] Power lever right	Idle
[ ] Auto feather	As required

Power lever microswitch test:

[ ] Power levers	Idle
[ ] PWR LEV TEST switch	Press
[ ] PWR LEV TEST light:	On

Anti ice systems test:

[ ] Power levers	Idle + 15%
[ ] Bleed air left & right	On
[ ] PNEU LOW PRESS light:	Out
[ ] De-ice boots	Man
[ ] Inner/Outer wing	Toggle
[ ] Left/Right stab	Toggle
[ ] STAB DE-ICE PRESS light left & right:	On
[ ] De-ice boots	As required
[ ] Power levers	Advance to 80% Ng
[ ] Intake deflector	Extend
[ ] De-Ice Dollseyes:	EXT
[ ] Intake deflector	Retract
[ ] De-Ice Dollseyes:	Blank
[ ] Power levers	Idle
[ ] Bleed air left & right	As required
[ ] Generator left & right	Off
[ ] Propeller de-ice	On, Check battery load increase
[ ] Propeller de-ice	Off
[ ] Windshield heat	On, Check battery load increase

[ ] Windshield heat	Off
[ ] Generator left & right	On

Before takeoff checks:

[ ] Trim tabs	Set
[ ] Flaps	10 Degr.
[ ] Flight instruments	Check
[ ] Radios	Set
[ ] Propeller levers	Full forward
[ ] Auto feather	On
[ ] SELECT light:	On
[ ] Engine instruments	Check
[ ] Bleed air left & right	As required
[ ] De-Ice	As required

Line-up checks:

[ ] Flight controls	Free
[ ] Transponder	On
[ ] Landing lights	On
[ ] Strobe lights	On
[ ] Caution lights	As appropriate
[ ] Runway and heading	Check

After takeoff 400 ft AGL:

[ ] Flaps	Up
[ ] Autofeather	Off
[ ] Climb power	Set
[ ] Nosewheel steering	Centreed
[ ] Yaw damper	On
[ ] Signs	As required
[ ] Landing lights	Off

Descend checks:

[ ] Fuel quantity/Selector	Check/Set
[ ] Hydraulic pressure	Check
[ ] Caution lights	Check
[ ] De-Ice	As requires
[ ] Altimeters	Set

Approach checks:

[ ] Signs	On
[ ] Landing lights	On

Before landing checks:

[ ] Nosewheel steering	Centreed
[ ] Yaw damper	Off
[ ] Flaps	Set
[ ] Propeller levers	Full forward

After landing checks:

[ ] Flaps	Up
[ ] Bleed air left & right	Off
[ ] De-Ice	Off
[ ] Landing lights	Off
[ ] Strobe lights	Off
[ ] Transponder	Off
[ ] Trim tabs	Reset for takeoff

Shutdown checks:

[ ] Parking brake	Set
[ ] Radios	Off
[ ] Power levers	Idle
[ ] Propeller levers	Feather (Float & Amphibian fitted with startlocks: Full forward)
[ ] Generators	Off
[ ] Fuel levers	Off
[ ] Boost pumps	Off
[ ] Lights	Off all
[ ] External/Battery switch	Off
[ ] D.C Master	Off
[ ] Control locks	Attached

ABBREVIATIONS

A		
A/C	Aircraft	Flugzeug
ACL	Anti Collision Light	Kollisionswarnlichter
ADF	Automatic Direction Finder	Automatisches Peilgerät
ADI	Attitude Director Indicator	Fluglageanzeiger
AGL	Above Ground Level	Höhe über Grund
AIS	Aeronautical Information Service	Flugberatungsdienst (DFS)
ALT	Altitude	Höhe
AP	Autopilot	Autopilot
APP	Approach	Landeanflug
APU	Auxiliary Power Unit	Hilfstriebwerk
ATC	Air Traffic Control	Flugverkehrskontrolle
B		
B/C	Back Course	Rückseitenkurs eines ILS
BARO	Barometric	Barometische Höhenmessung
BRK	Break	Bremsen
C		
CL/CLB	Climb	Steigflug
CPT/CAPT	Captain	Kapitän
CRS	Course	Flugkurs
D		
DES	Descent	Sinkflug
DFDR	Digital Flight Data Recorder	Digitaler Flugschreiber
DIR	Direct	Direkt
DME	Distance Measuring Equipment	Entfernungsmessanlage
DOW	Dry Operating Weight	Leergewicht ohne Sprit
E		
ENG	Engine	Triebwerk
EXT LT	External Lights	Externe Beleuchtung
EXT PWR	External Power	Externe Stromversorgung
F		
FCOM	Flight Crew Operating Manual	Flughandbuch
FD	Flight Director	Fluglageanzeige
FDR	Flight Data Recorder	Flugdaten Aufzeichnungsgerät

FF	Fuel Flow	momentaner Treibstoffverbrauch
FL	Flight Level	Flugfläche
FO	First Officer	1. Offizier
FOB	Fuel on Board	Treibstoffvorrat
FQ	Fuel Quantity	Treibstoffmenge
G		
GAFOR	General Aviation Forecast	Flugwettervorhersage
GPS	Global Positioning System	Globales Positionierungssystem
GPU	Ground Power Unit	Stromversorgung am Boden
GPWS	Ground Proximity Warning System	Bodenannäherungswarnsystem
GS	Glide Slope	Gleitpfad
GW	Gross Weight	Gesamtfluggewicht
H		
HDG	Heading	Richtung - Kompasskurs
HSI	Horizontal Situation Indicator	Instrument für die Funknavigation
I		
IAS	Indicated Airspeed	angezeigte Fluggeschwindigkeit
IDLE	IDLE Power	Leerlaufschub
IFR	Instrument Flight Rules	Instrumentenflugregeln
ILS	Instrument Landing System	Instrumentenlandesystem
J		
Jet A	Jet Fuel	Turbinen Treibstoff (Kerosin)
K		
KIAS	Knots Indicated Airspeed	Angez. Geschwindigkeit in Knoten
L		
LAW	Landing Weight	Gew. des Flugzeuges bei Landung
LFZ	Aircraft	Luftfahrzeug
LOC	Localizer	Landekurssender
M		
M/A	Missed Approach	Fehlanflug
MC	Master Caution	Hauptwarnlampe
MCA	Minimum Cruising Altitude	Mindestreiseflughöhe
METAR	Met. Av. Routine Weather Report	Planmäßige Flugwettermeldung
MLW	Maximum Landing Weight	Höchstlandegewicht
MTOW	Maximum Take-Off Weight	Höchstabfluggewicht
N		
NAM	Nautical Air Miles	Nautische Luftmeilen

NAV	Navigation	Navigation, VOR-Empfänger
NG	Gas Generator Speed	Drehzahl Gasgenerator
NOTAMS	Notice to Airmen	Info Änderungen i. d. Luftfahrt
NP	Propeller Speed	Drehzahl Propeller
NWS	Nose Wheel Steering	Bugradsteuerung
O		
OAT	Outside Air Temperature	Außentemperatur
OBS	Omni Bearing Selector	Kurswahlknopf d. VOR-Anzeige
P		
PIC	Pilot in Command	Verantwortlicher Luftfahrzeugführer
PSI	Pounds per Square Inch	Druckeinheit
PTH	Pitch	u.a. Neigungswinkel
Q		
QNH	Seal Level Atmosphere Pressure	Luftdruck auf Meereshöhe
R		
RCAF	Royal Canadian Air Force	Kanadische Luftstreitkräfte
RPM	Rounds Per Minute	Umdrehungen pro Minute
S		
SHP	Shaft Horse Power	Leistung an der Propellerwelle
SOP	Standard Operating Procedure	Standard Betriebsverfahren
SOV	Shut-off Valves	Absperrventile
T		
T5	Gas Turbine Temperature	Temperatur der Gasturbine
TAF	Terminal Aerodrome Forecast	Flughafen-Wettervorhersage
TF	Trip Fuel	Treibstoff für Route ohne Reserve
T/O	Take Off	Start
TOW	Take Off Weight	Startgewicht
U		
UTC	Universal Coordinated Time	Koordinierte Weltzeit
V		
V1	Decision Speed	Startabbruchgeschwindigkeit
V2	Climb Safety Speed	sichere Steiggeschwindigkeit
VB	Gust Penetration Speed	max. Manövergeschw. bei Böen
VEF	Engine Failure Speed	Startgeschw. Triebwerksausfall
VFE	Max. Flap Extended Speed	Höchstgeschw. mit Klappen
VFR	Visual Flight Rules	Sichtflugbedingungen
VLOF	Liftoff Speed	Abhebegeschwindigkeit

VMC	Minimum Control Speed	Mindestgeschwindigkeit
VMO	Max. Operating Speed	max. zulässige Fluggeschwindigkeit
VNE	Never Exceed Speed	nicht zu überschr. Geschwindigkeit
VNO	Norm. Operating Limit	höchste Fluggeschw. Normalbetrieb
VR	Rotation Speed	Geschw. zum Rotationszeitpunkt
VREF	Referential Speed	Referenzgeschwindigkeit
VS	Stall Speed	Überziehgeschwindigkeit
Vx	Best Angle of Climb	Fluggeschw. f. besten Steigwinkel
Vy	Best Rate of Climb Speed	Fluggeschw f. die beste Steigrate
W		
WPT	Waypoint	Wegpunkt
WXR	Weather Radar	Wetterradar
X		
XPDR	Transponder	Transponder
Y		
Y/D	Yaw Damper	Gierdämpfer
Z		
ZFW	Zero Fuel Weight	Gew. m. Nutzlast m. leeren Tanks

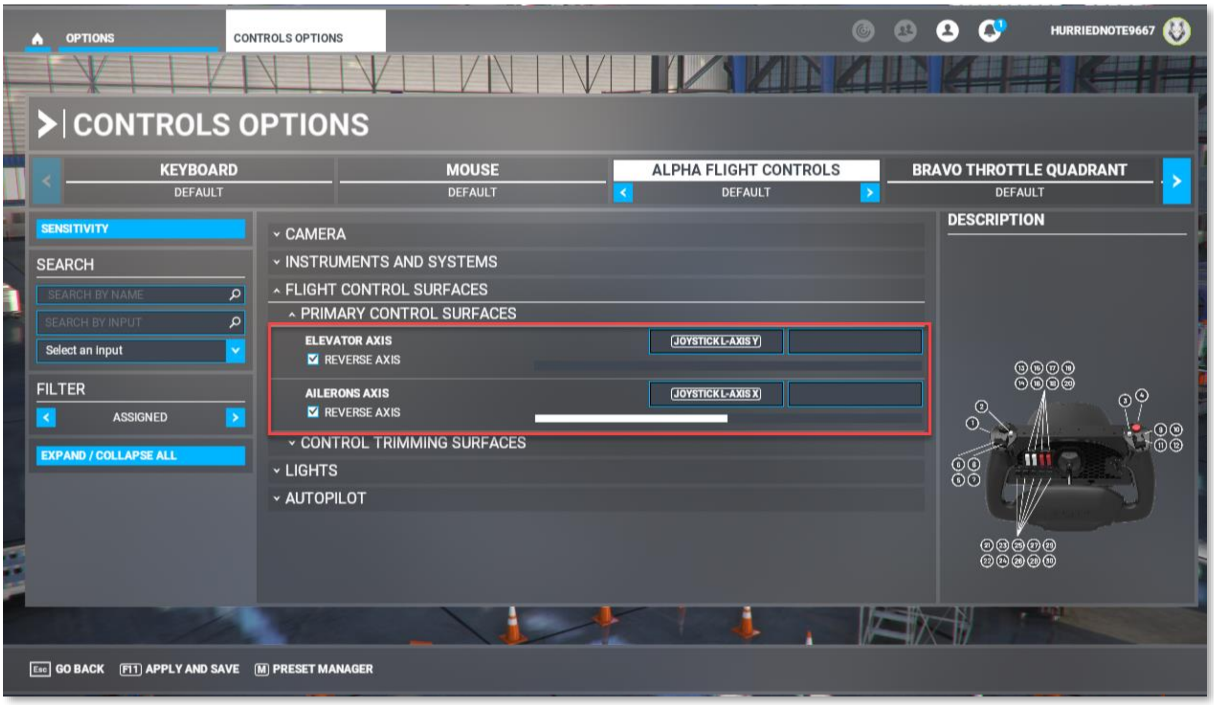
SETTING UP BASIC HARDWARE CONTROLS

This section will focus on configuring your hardware to steer the Twin Otter. It is a general-purpose method; however, we will demonstrate it using the Honeycomb Alpha Yoke and the Honeycomb Bravo Throttle.

AILERONS AND ELEVATOR

Make the following assignments in MSFS:

- Goto OPTIONS -> CONTROLS OPTIONS
- Assign AILERONS AXIS and ELEVATOR AXIS to the yoke roll and pitch axes

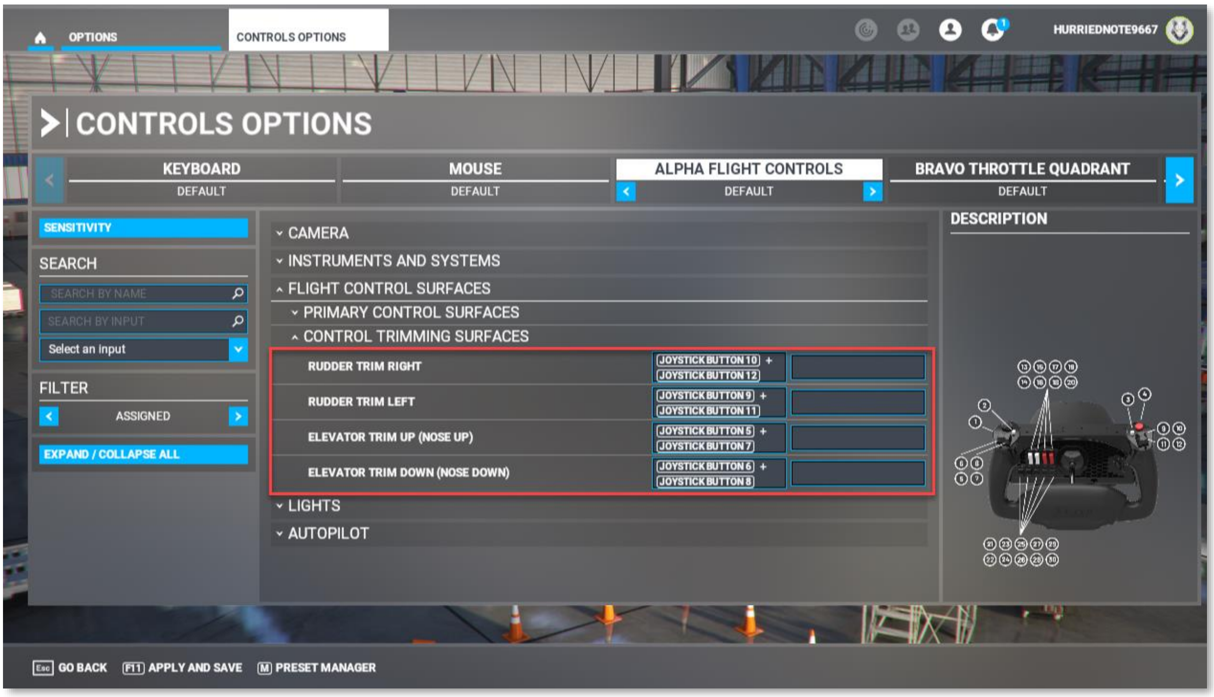


ELEVATOR AND RUDDER TRIMS

NOTE: If you use the elevator trim wheel on the Bravo throttle, DO NOTassign the elevator trimming function on the yoke as it may result in multiple assignments and signal conflict.

Make the following assignments in MSFS:

- Goto OPTIONS -> CONTROLS OPTIONS
- Assign RUDDER TRIM RIGHT/LEFT to the rocker switches on the right of the yoke.
- Assign ELEVATOR TRIM UP/DOWN the rocker switches on the left of the yoke



THROTTLE AND REVERSERS

Make the following assignments in MSFS:

- Goto OPTIONS -> CONTROLS OPTIONS
- Assign THROTTLE (1)(2) AXIS to the two left levers
- Assign THROTTLE(1)(2) DECREASE to the levers detent contacts
  This will trigger the reversers

PROPELLER PITCH AND FEATHER

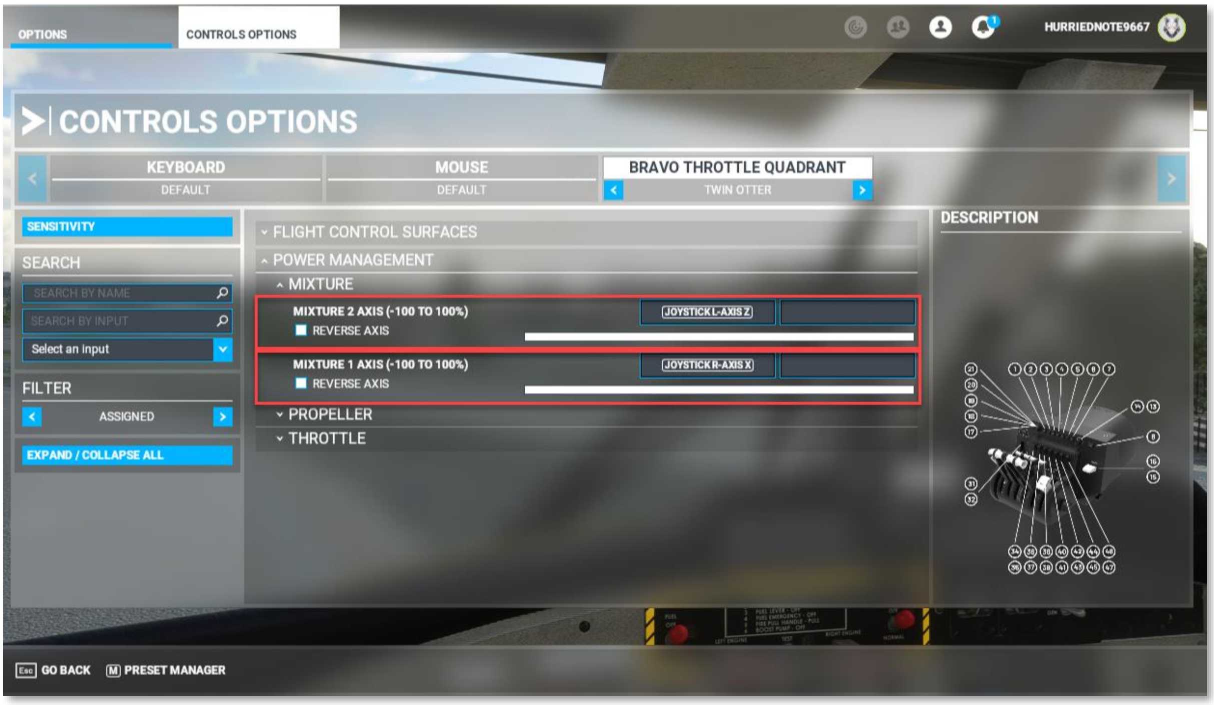
Make the following assignments in MSFS:

- Goto OPTIONS -> CONTROLS OPTIONS
- Assign PROPELLER (1)(2) AXIS to the two middle levers
- Assign TOGGLE PROPELLER REVERSE THRUST to the left propeller lever detent so that when advancing the propeller levers, they will move back up to the FEATHER position. To go back to normal pitch operation, toggle the detent again.

FUEL CUTOFF

Make the following assignments in MSFS:

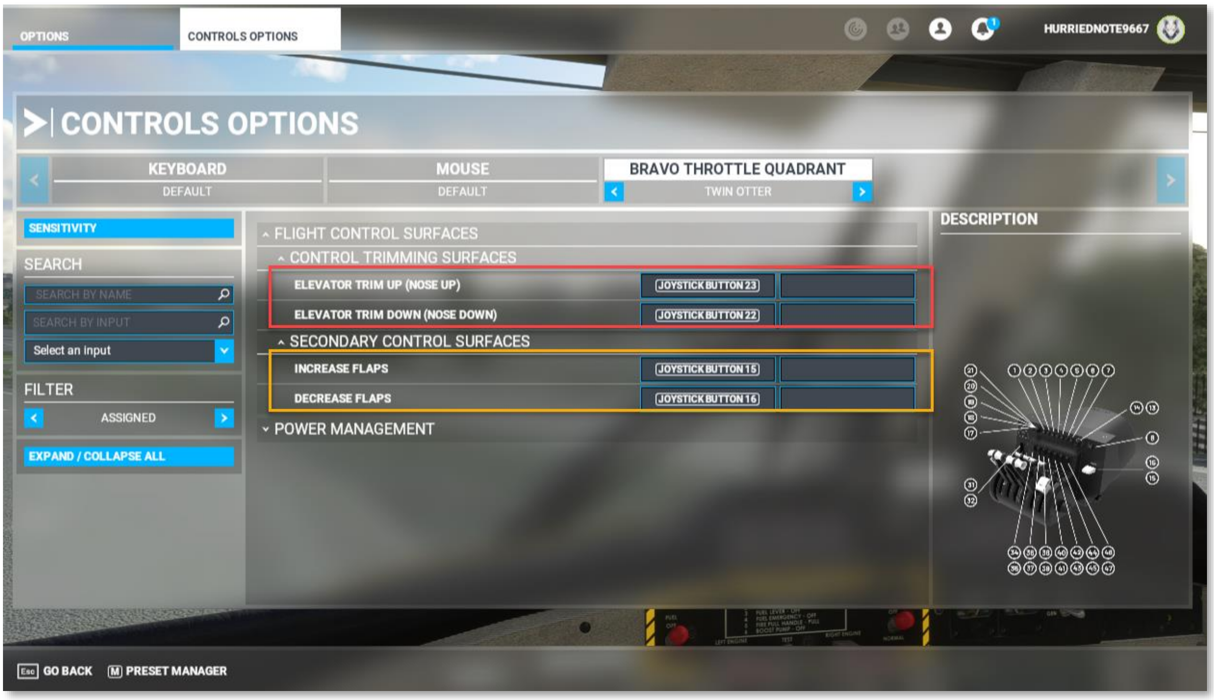
- Goto OPTIONS -> CONTROLS OPTIONS
- Assign MIXTURE (1)(2) AXIS (-100 to 100%) to the two right levers



ELEVATOR TRIM & FLAPS CONTROL

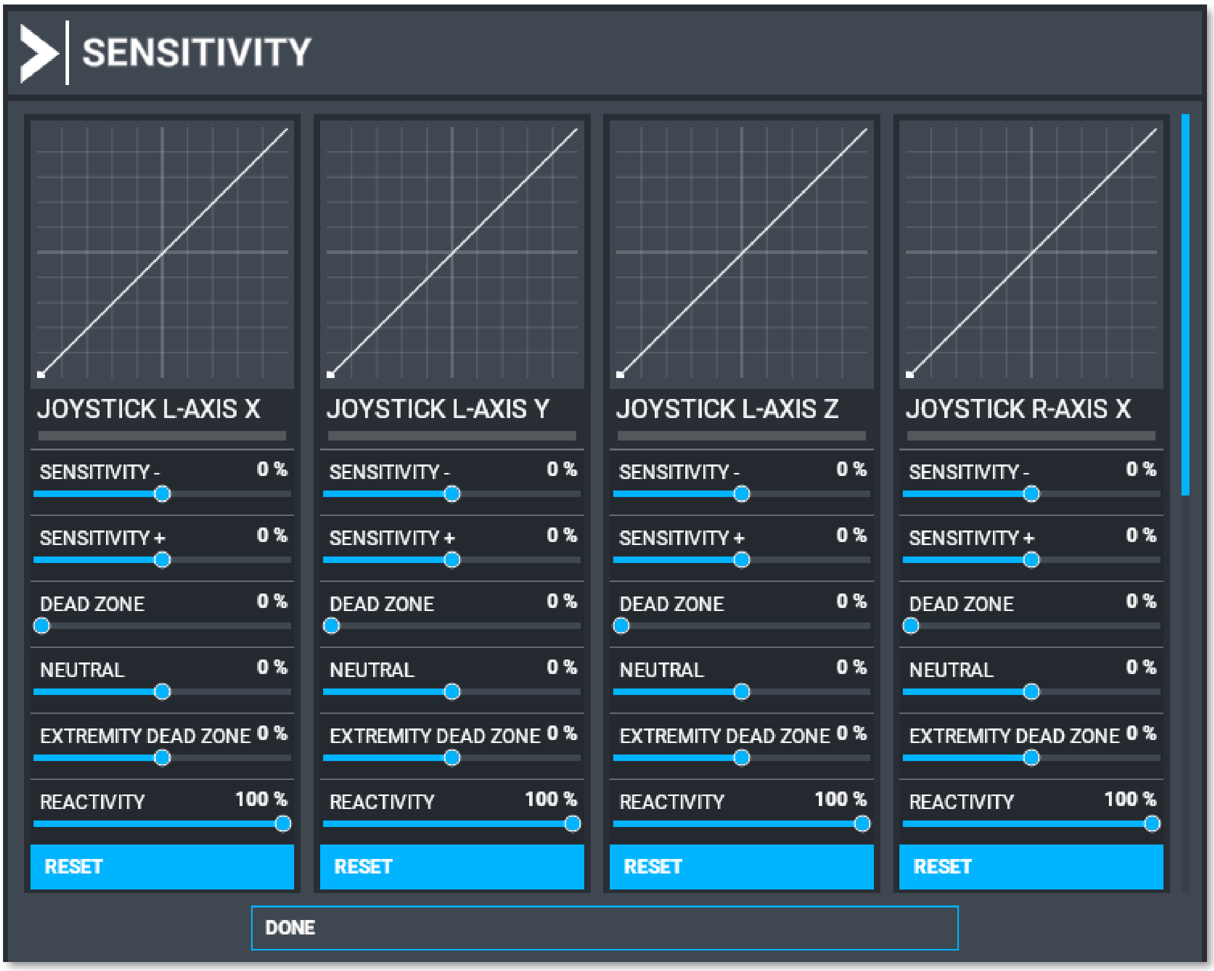
Make the following assignments in MSFS:

- Goto OPTIONS -> CONTROLS OPTIONS
- Assign ELEVATOR TRIM UP/DOWN TO the trim wheel inputs
- Assign INCREASE/DECREASE FLAPS to the flaps switch input



SENSITIVITIES

Ensure the sensitivity curve is linear and reactivity is 100% for all axes.



MICROSOFT FLIGHT SIMULATOR KEY COMMANDS

MENU

- Toggle active PAUSE – PAUSE
- Toggle basic control panel – CTRL + c
- Clear search – DEL
- Toggle PAUSE – ESC
- Select 1 – ALT + F1
- Select 2 – ALT + F2
- Select 3 – ALT + F3
- Select 4 – ALT + F4
- Display checklist – SHIFT + c
- Next toolbar panel – .
- Previous toolbar panel – /
- Back to main menu – END
- Close menu – BACKSPACE
- Fly – ENTER
- Change aircraft – F11
- Liveries – F12
- See specifications – F10
- Help menu – Tab
- Restart free flight – HOME
- Restart activity – HOME

MISCELLANEOUS

- Toggle Fuel Pump – ALT + p
- Toggle Marker Sound – CTRL + 3
- Minus – CTRL + NUM MINUS
- PLUS – CTRL + NUM PLUS
- Toggle Pushback – SHIFT + p
- Request Fuel – SHIFT + f
- Display Navigation log – n
- Display Map – v
- Sim Rate – r
- Skip RTC – BACKSPACE
- New Ui Window Mode – Right ALT
- Toggle Control to Copilot – CTRL + ALT + X

INSTRUMENTS AND SYSTEMS

- Toggle Anti Ice – h
- Toggle Pitot heat – SHIFT + h
- Toggle master Alternator – ALT + a
- Toggle master Battery – ALT + b
- Toggle master Battery and Alternator – SHIFT + m
- Decrease cowl flap – SHIFT + CTRL + c
- Select Engine – e
- Auto start engine – CTRL + e
- Engine Stop – SHIFT + CTRL + e

- Increase Cowl flap – SHIFT + CTRL + v
- Magneto – m
- Magnetos both – SHIFT + ALT + F
- Magnetos left – SHIFT + ALT + s
- Magnetos off – SHIFT + ALT + q
- Magnetos right – SHIFT + ALT + d
- Magnetos start – SHIFT + ALT + g
- Toggle master ignition switch – ALT + i

FLIGHT INSTRUMENTS

- Select airspeed bug – SHIFT + CTRL + r
- Select Altitude bug – SHIFT + CTRL + z
- Toggle Auto rudder – SHIFT + CTRL + u
- Set Altimeter – b
- Decrease heading bug – CTRL + DEL
- Increase heading bug – CTRL + Insert
- Select heading bug – SHIFT + CTRL + h
- Set heading indicator – d
- Toggle Alternate Static – ALT + s

FUEL

- Toggle fuel dump – SHIFT + CTRL + d
- Fuel Selector 1 all – ALT + w
- Fuel Selector 1 off – CTRL + ALT + w
- Toggle all fuel valve – ALT + v

INSTRUMENT VIEWS

- Previous instrument view – SHIFT + a
- Next instrument view – a
- Toggle instrument view 10 – CTRL + 0
- Toggle instrument view 1 – CTRL + 1
- Toggle instrument view 2 – CTRL + 2
- Toggle instrument view 3 – CTRL + 3
- Toggle instrument view 4 – CTRL + 4
- Toggle instrument view 5 – CTRL + 5
- Toggle instrument view 6 – CTRL + 6
- Toggle instrument view 7 – CTRL + 7
- Toggle instrument view 8 – CTRL + 8
- Toggle instrument view 9 – CTRL + 9
- Select next POI – PageUp
- Reset Smart Cam – CTRL + f
- Set custom Smart Cam target – t
- Next Smart Cam target – PageUp + CTRL
- Camera AI Player – HOME + CTRL
- Previous Smart Cam target – PageDown + CTRL
- Toggle follow Smart Cam target – PageDown
- Unset custom Smart Cam target – SHIFT + t

CAMERA – SLEW MODE

- Slew translate up (slow) – F3
- Slew translate up (fast) F4
- Slew translate backward – NUM 2
- Slew translate forward – NUM 8
- Slew translate down (Fast) – F1
- Slew translate down (slow) – a
- Slew Y axis translation freeze – F2
- Slew roll left – NUM 7
- Slew roll right – NUM 9
- Slew X Axis translation freeze – NUM 5
- Slew Yaw left – NUM 1
- Slew Yaw right – NUM 3
- Slew translate left – NUM 4
- Slew pitch down (fast) – F8
- Slew Pitch freeze – F6
- Slew pitch down – NUM 0
- Slew pitch up – 9
- Slew pitch up (fast) F5
- slew pitch up (slow) F7
- Slew translate right – NUM 6
- Toggle slew mode – y

CAMERA MODE SWITCHES

- Cockpit/External view mode – END
- Toggle Drone – Insert

COCKPIT CAMERA

- Load Custom Camera 0 – ALT + 0
- Load Custom Camera 1 – ALT + 1
- Load Custom Camera 2 – ALT + 2
- Load Custom Camera 3 – ALT + 3
- Load Custom Camera 4 – ALT + 4
- Load Custom Camera 5 – ALT + 5
- Load Custom Camera 6 – ALT + 6
- Load Custom Camera 7 – ALT + 7
- Load Custom Camera 8 – ALT + 8
- Load Custom Camera 9- ALT + 9
- Load next custom camera – k
- Load previous custom camera – SHIFT + k
- Save custom camera 0 – CTRL + ALT + 0
- Save custom camera 1 – CTRL + ALT + 1
- Save custom camera 2 – CTRL + ALT + 2
- Save custom camera 3 – CTRL + ALT + 3
- Save custom camera 4 – CTRL + ALT + 4
- Save custom camera 5 – CTRL + ALT + 5
- Save custom camera 6 – CTRL + ALT + 6
- Save custom camera 7 – CTRL + ALT + 7
- Save custom camera 8 – CTRL + ALT + 8

- Save custom camera 9 – CTRL + ALT + 9
- Decrease cockpit view height – Down
- Increase cockpit view height – Up
- Translate cockpit view backward – Right ALT + Down
- Translate Cockpit view forward – Right ALT + Up
- Translate Cockpit view left – Left
- Translate Cockpit view right – Right
- Cockpit look down – SHIFT + Down
- Cockpit look left – SHIFT + Left
- Cockpit look right – SHIFT + Right
- Cockpit look up – SHIFT + up
- Cockpit quick view up – CTRL + Up
- Cockpit quick view rear – CTRL + Down
- Cockpit quick view right – CTRL + Right
- Cockpit quick view left – CTRL + Left
- Cockpit quick view cycle – q
- Reset cockpit view – CTRL + Space
- Cockpit view upper – Space
- Reset zoom Cockpit view – –
- Toggle smart camera – s
- Zoom cockpit view – =

DRONE CAMERA

- Toggle drone depth of field – F1
- Toggle foreground blur – F5
- Drone top down view – CTRL + Space
- Attach drone to next target – CTRL + Page Up
- Attach drone to previous target – CTRL + Page Down
- Toggle drone auto exposure – CTRL + F4
- Toggle drone auto focus – F4
- Decrease drone rotation speed – F3
- Decrease drone translation speed – F1
- Decrease drone depth of field – F2
- Increase drone depth of field – F3
- Decrease drone exposure – CTRL + F2
- Increase drone exposure – CTRL + F3
- Increase drone rotation speed – F4
- Increase drone translation speed – F2
- Lock drone to next target – t
- Lock drone to previous target – SHIFT + t
- Translate drone backward – s
- Translate drone down – f
- Translate drone forward – w
- Translate drone left – a
- Translate drone right – d
- Translate drone up – r
- Reset Drone roll – space
- Reset drone target offset – NUM 5
- Pitch drone down – NUM 2
- Roll drone right – NUM 9

- Pitch drone up – NUM 8
- Yaw drone left – NUM 4
- Yaw drone right – NUM 6
- Roll drone left – NUM 7
- Toggle drone follow mode – Tab
- Toggle drone lock mode – CTRL + Tab
- Increase drone zoom – NUM PLUS
- Decrease drone zoom – NUM MINUS
- Toggle Plane Controls – c

EXTERNAL CAMERA

- Reset External view – CTRL + Space
- External quick view left – CTRL + Left
- External quick view rear – CTRL + Down
- External quick view right – CTRL + Right
- External quick view top – CTRL + Up
- Reset Zoom External view – –
- Zoom external view – =

FIXED CAMERA

- Toggle fixed camera 10 – CTRL + SHIFT + 0
- Toggle fixed camera 1 – CTRL + SHIFT + 1
- Toggle fixed camera 2 – CTRL + SHIFT + 2
- Toggle fixed camera 3 – CTRL + SHIFT + 3
- Toggle fixed camera 4 – CTRL + SHIFT + 4
- Toggle fixed camera 5 – CTRL + SHIFT + 5
- Toggle fixed camera 6 – CTRL + SHIFT + 6
- Toggle fixed camera 7 – CTRL + SHIFT + 7
- Toggle fixed camera 8 – CTRL + SHIFT + 8
- Toggle fixed camera 9 – CTRL + SHIFT + 9
- Reset fixed camera – f
- Previous fixed camera – SHIFT + a
- Next fixed camera – a

AUTOPILOT

- Autopilot Airspeed Hold – ALT + r
- Decrease autopilot reference Altitude – CTRL + PageDown
- Increase autopilot reference Altitude – CTRL + PageUp
- Toggle autopilot approach hold – CTRL + a
- Toggle autopilot attitude hold – CTRL + t
- Toggle autopilot localizer hold – CTRL + o
- Toggle autopilot mach hold – CTRL + m
- Toggle autopilot master – z
- Autopilot N1 hold – CTRL + s
- Decrease autopilot N1 reference – CTRL + END
- Increase autopilot N1 reference – CTRL + HOME
- Autopilot Nav1 Hold – CTRL + n
- Decrease autopilot reference airspeed – SHIFT + CTRL + DEL
- Increase autopilot reference airspeed – SHIFT + CTRL + Insert

- Decrease autopilot reference vs – CTRL + END
- Increase autopilot reference vs – CTRL + HOME
- Toggle autopilot wing leveler – CTRL + v
- Autopilot Off – SHIFT + ALT + z
- Autopilot On – ALT + z
- Arm Auto Throttle – SHIFT + r
- Auto Throttle to GA – SHIFT + CTRL + g
- Toggle avionics master – PageUp
- Toggle flight director – CTRL + f
- Toggle Yaw Damper – CTRL + d

BRAKES

- Brakes – NUM Decimal
- Left Brake – NUM Multiply
- Right Brake – NUM MINUS
- Toggle Parking Brakes – CTRL + NUM Decimal

FLIGHT CONTROL SURFACES

- Aileron left (roll left) – NUM 4
- Aileron right (roll right) – NUM 6
- CENTER ailerons & rudder – NUM 5
- Elevator down – NUM 8
- Elevator up – NUM 2
- Toggle water rudder – CTRL + w
- Rudder left – NUM 0
- Rudder Right – ENTER

SECONDARY CONTROL SURFACES

- Decrease flaps – F6
- Extend flaps – F8
- Increase flaps – F7
- Retract flaps – F5
- Toggle spoilers – NUM Divide

CONTROL TRIMMING SURFACES

- Aileron Trim Left – CTRL + NUM 4
- Aileron Trim Right – CTRL + NUM 6
- Rudder Trim Left – CTRL + NUM 0
- Rudder Trim Right – CTRL + ENTER
- Elevator Trim Down (nose down) – NUM 7
- Elevator Trim up (Nose up) – NUM 1

LANDING GEAR

- Toggle landing gear – g
- Gear down – CTRL – g
- Toggle tail wheel lock – SHIFT + g

EXTERIOR LIGHTS

- Toggle landing lights – CTRL – l
- Landing lights down – SHIFT + CTRL + NUM 2
- Landing light HOME – SHIFT + CTRL + NUM 5
- Landing light left – SHIFT + CTRL + NUM 4
- Landing light right – SHIFT + CTRL + NUM 6
- Landing light up – SHIFT + CTRL + NUM 8
- Toggle strobes – o
- Toggle beacon light – ALT + h
- Toggle Nav light – ALT + n
- Toggle taxi lights – ALT + j

INTERIOR LIGHTS

- Toggle flashlight – ALT + l
- Toggle lights – l

POWER MANAGEMENT MIXTURE

- Decrease mixture – SHIFT + CTRL + F2
- Increase mixture – SHIFT + CTRL + F3
- set mixture lean – SHIFT + CTRL + F1
- set mixture rich – SHIFT + CTRL + F4

POWER MANAGEMENT PROPELLER

- Decrease propeller pitch – CTRL + F2
- Propeller pitch Hi – CTRL + F4
- Increase propeller pitch – CTRL + F3
- Propeller pitch lo – CTRL + F1

THROTTLE

- Throttle cut – F1
- Decrease Throttle – F2
- Increase Throttle – F3

RADIO

- ADF – SHIFT + CTRL + a
- Com Radio – c
- Set Com1 Standby – SHIFT + ALT + x
- Com1 switch to standby – ALT + u
- DME – f
- Decrease Nav1 Frequency – SHIFT + CTRL + PageDown
- Increase Nav1 Frequency – SHIFT + CTRL + PageUp
- Nav1 Swap – SHIFT + CTRL + n
- Nav Radio – n
- Decrease Vor1 OBS – SHIFT + CTRL + END
- Increase VOR1 OBS – SHIFT + CTRL + HOME
- VOR OBS – SHIFT + v
- Transponder – t

- Set transponder – SHIFT + ALT + w
- Display ATC – Scroll Lock
- ATC Panel Choice 0 – 0
- ATC Panel Choice 1 – 1
- ATC Panel Choice 2 – 2
- ATC Panel Choice 3 – 3
- ATC Panel Choice 4 – 4
- ATC Panel Choice 5 – 5
- ATC Panel Choice 6 – 6
- ATC Panel Choice 7 – 7
- ATC Panel Choice 8 – 8
- ATC Panel Choice 9 – 9
- Frequency Swap – x
- Increase wheel speed – SHIFT