FS ACADEMY

IN COMMAND

CONTENTS

INTRODUCTION

In this course, we will look at the demands placed upon an aircraft commander. We will look at the technical and non-technical skills required to effectively manage an aircraft in difficult circumstances such as closed runways and system failures.

The course itself is comprised of this User Manual & 6 Missions.

The missions are organised under the FS Academy – In Command Missions category within FSX and can be completed in any order. They have varying levels of difficulty. Mission Briefings are contained within this manual.

To get the best experience, read through this manual before tackling the missions, as it will arm you with the information and techniques you'll need as the Commander to work through the difficult situations that await you. The Failure Management section will have particular importance and is used in each mission.

The Ground School will cover:

- The role and responsibility of The Commander
- Management of system failures and difficult situations
- The decision-making process
- Fuel Planning
- Aircraft Loading
- Altimetry
- Airport Facilities, Lighting and Markings
- ICAO Annexes and Airport Codes
- Hazardous Weather
- Decoding METAR & TAF Weather Reports
- And more…

The skills you will learn from FS Academy - In Command are transferable to almost any aircraft, from a Cherokee or a Jumbo Jet, the decision-making process is effectively the same.

Let's get started…

SOFTWARE SETTINGS

You can tailor your settings so that you experience FS Academy – In Command as you wish, the recommended settings are shown here, which will provide the most guidance and support.

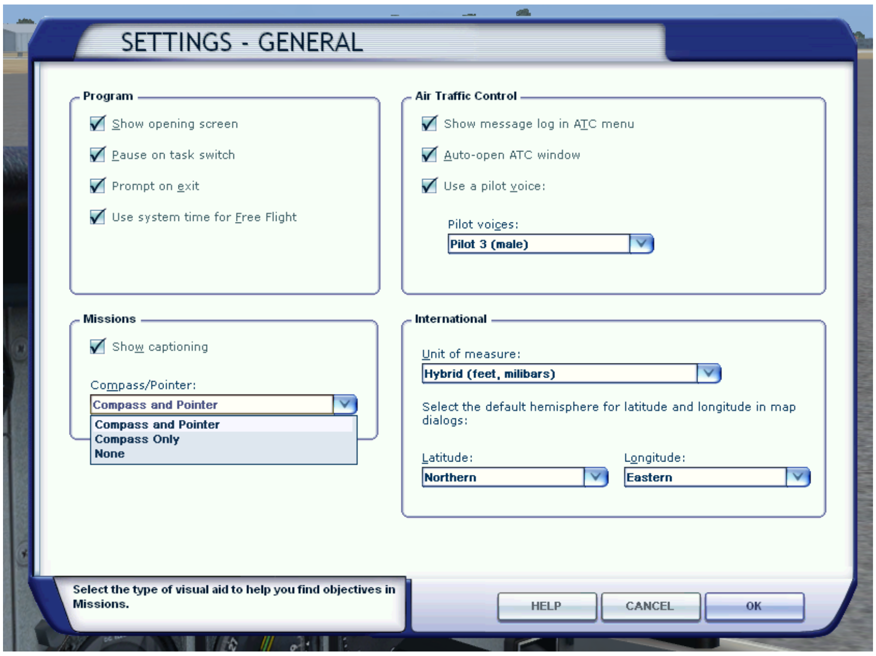
Sound

The mission voiceovers will explain what to do as you go along. Using the Sound settings in FSX, set your volumes as required so you can hear your instructions clearly. Captions can also be enabled, allowing you to read along. Captions can be enabled in the General Settings menu.

By opening the Kneeboard from the Aircraft->Kneeboard option in FSX, you can see the log of messages as the mission progresses.

Realism

Directional guidance will be in the form of a location marker to fly towards and the compass at the top left corner of the screen. If these does not show, enable the Compass and Pointer option from the drop-down menu found under General Settings.



Crash Tolerance and other settings are over-ridden in some missions to ensure a consistent experience and avoid crash detection, particularly for the Pisa mission which features abnormal landing gear.

You will encounter engine trouble in some missions, it is recommended that Auto-Rudder is DISABLED in the realism settings, as this will allow full manual rudder control.

MISSIONS BRIEFINGS

Missions in FS Academy – In Command can be completed in any order and all are completed with a successful landing and full stop on the runway.

While prior study of the entire Ground School would be most rewarding, study of the Failure Management section in particular will be of great benefit for all missions.

Pisa

Location	Pisa, Italy
Aircraft	Beechcraft Baron
Duration	20 Mins
Difficulty	Expert

Depart a dark Pisa airport and soon after lift-off encounter a system failure that limits your options and requires careful diagnosis. Climb away and head West to troubleshoot. Arrive at a decision and attempt an approach. Things then go downhill quickly, as you face a further issue with your systems.

A high level of handling skill will be required for a safe landing, as you will be touching down with an abnormal landing gear configuration. Use the controls to keep the right wing flying for as long as possible after landing, allowing it to settle onto the tarmac as smoothly as you can.

To achieve a successful outcome, you must land as smoothly as possible, slowing to a stop while remaining on the runway. The aircraft will try to pull to the right after landing, but this must be anticipated and accounted for. Veering off the side of the runway will not be considered as a success.

Naples

Location	Naples, Italy
Aircraft	Cessna 208 Grand Caravan
Duration	10 Mins
Difficulty	Intermediate

Line up and take off from Naples, but keep your wits about you, as Volcanic activity has been reported nearby. Mt. Vesuvius seems to be spewing ash, although it is reportedly to the south of your route.

The accuracy of these reports will come into question once established in the climb, as a blocked pitot, straining engine and static problems mean you'll find yourself turning around.

Volcanic ash is a very real threat to aircraft, especially those with turbine powered engines such as our Cessna Grand Caravan. The ash can solidify and change to a glass-like material on the turbine blades, causing engine failure at worst or reduced thrust at best.

Climbing away from Naples you will encounter a scenario such as this, which will need a quick response to ensure the aircraft is flying at a safe speed. If pitch is maintained but power reduced, your airspeed will of course decrease, inching you towards a stall. This mission will rely on the need to Aviate first, to set the aircraft with a safe attitude, before dealing with subsequent difficulties.

Study of the Volcanic Ash and Unreliable Airspeed sections will provide useful insight.

Madeira

Location	Funchal, Portugal
Aircraft	CRJ
Duration	15 Mins
Difficulty	Expert

You join the mission whist enroute to Funchal Airport, notorious for difficult weather conditions and landings. You have flown over from Porto Santo, a neighbouring island, but have found yourself forced off-track by thunderstorms. An event will cause an engine fire, amongst other failures and aircraft damage. With a burning engine, you'll have to get us on the deck as quickly as possible.

Strong winds compound your handling problems, making this a truly difficult experience. You may find maintaining altitude becomes impossible as you lose engine power, make sure to stay at an airspeed higher than the VMCA blue line on the ASI, as you will lose control if you stray below it.

Time is of the essence in this scenario, so a quick assessment of risk will be performed to decide between a tricky turning final approach versus coming straight in but with a strong tailwind, greatly increasing landing distance.

The distance required to stop an aircraft can increase dramatically with tailwinds, as your inertia/energy levels can be far greater in comparison to a headwind. For example, if an aircraft has an indicated target landing speed of 100kts, with a head wind of 20kts, your effective energy levels are for travelling at 80kts, as opposed to 120kts landing in the opposite direction. For a heavy aircraft, a 40kt increase in ground speed involves a huge increase in energy, which must be absorbed by braking.

Descending on the approach is also more difficult with a tailwind, as the increase in ground speed demands a higher rate of descent to maintain the same glidepath. See the Rules of Thumb section of the manual for more details on this.

As an example, the Airbus A320 is only certified up to between 10-15kts tailwind.

An inextinguishable fire is arguably the most severe emergency for an aeroplane, as the time from the fire starting until grave structural damage causes loss of control can be as little as 10 minutes.

It doesn't have to be pretty, just get the job done.

Coromandel

Location	Near Thames, New Zealand
Aircraft	Maule
Duration	10 Mins
Difficulty	Intermediate

Your gentle wander through the snowy Northern Island valleys is interrupted by a worsening flight control problem. Initially try the controls to see what you have remaining, before cutting your trip short and setting down at Thames. Delicate control will be rewarded, as only rudder control will be available for making turns.

Use any runway at Thames, whichever you feel would be easiest to make an approach to. But don't forget to consider the terrain beyond the runway, in case of a missed approach.

Flying in icy conditions can be hazardous, as you are about to experience. An accumulation of icing can worsen rapidly if you cannot escape the freezing temperatures due to restrictions such as ATC, terrain or aircraft performance. Once controls become obstructed, it is important to assess how well you can control the aircraft using the remaining controls available to you.

In the case of a frozen elevator, you could try to operate the pitch trim to provide a degree of pitch control, whereas ailerons can be partially replaced by rudder inputs. To steer using rudder alone, give yourself extra space to manoeuvre and limit the bank angle. It is important to be smooth with the controls as any inadvertent extreme attitudes may prove impossible to recover while you have limited control ability.

The rudder can be used to roll the aeroplane by smoothly applying rudder towards the side you wish to turn. This slows the inside wing while accelerating the outside wing, resulting in a difference in lift, causing roll. This effect is amplified on swept wing aeroplanes as the effective wing sweep per wing is also affected by yaw, causing even greater lift variations, requiring extreme care.

There are a few methods to help remedy icing conditions. The most effective is to climb or descend out of the snow or icy cloud. Descending is usually preferable as temperatures generally increase as you go lower. Speeding up can have a small but useful effect as the increased friction can warm the aircraft surfaces, providing some relief in certain circumstances. In this valley-based scenario, you are already at low altitude, with snow falling from above, so both climbing and descending are effectively ruled out.

Bournemouth

Location	Bournemouth, UK
Aircraft	King Air 350
Duration	25 Mins
Difficulty	Advanced

Taxi to the holding point in the as you prepare to depart the British seaside town of Bournemouth. You're planning a trip to Alderney, one of the UKs Channel Islands, which is a short flight south over the English Channel.

This scenario will begin with a severe systems malfunction, which will make for an easy decision to turn back. A less obvious solution will be needed after the situation deteriorates further, leading to a reassessment of your plan.

The Review part of the DODAR process exists to remind the commander that a reassessment may be required in the light of new information or a change in circumstances, which will be seen in this mission.

After departure, you will be stopped in your tracks by an electrical gremlin that will necessitate putting off your trip until another day.

Returning to Bournemouth becomes impossible as you are not the only one having difficulties today. Choose another destination and make your way towards it.

A further failure complicates matters but stick to your plan and set it down. Respect VMCA to stay in control, indicated by the blue line on the Airspeed Indicator. More on this is discussed in the Manual.

Manchester

Location	Barton, UK
Aircraft	Cessna 172
Duration	25 Mins
Difficulty	Intermediate

Beginning on the ground at Barton Airfield, after takeoff you will encounter a problem that causes damage to the left wing. Circle to the south of Barton and perform troubleshooting, leading to a decision of where to land. The rain is coming down and soaking the short grass strips at Barton, but Manchester International is a short flight to the south. After deciding on a plan of action, you'll get ATC clearance to fly to Manchester and land on 05L.

The rain has reduced visibility so keep your eyes peeled.

Landing distances are greatly affected by the surface conditions. Wet grass can be very slippery, providing very little grip for braking after landing or aborting a take-off. Careful thought should go into whether to attempt an approach to a wet grass strip while suffering a malfunction, as required landing distances can quickly increase and erode your safety margins towards zero.

This scenario will involve a control problem, which will need to be considered when choosing where to land. When considering options as part of the DODAR framework, landing distance should be considered, as it is common for it to be less risky to fly further in order to reach a more suitable runway, as opposed to rushing in to the nearest airfield and being tight on stopping distance.

It would be sensible to assume that the passengers and owners would be far happier to have a displaced aircraft that to hear one has been damaged due to poor decision making.

FAILURE MANAGEMENT

Some people say we should expect the unexpected. It would be impossible to predict and have a ready-made plan for every possible eventuality, however it is easy to have a simple system in place to help you through an issue, as and when it occurs.

When we encounter trouble, we first need to get the aircraft safely under control, then decide what our best course of action is. We can use a couple of easy systems to help us with this.

If there is one thing to take away from this course, it's this:

AVIATE - NAVIGATE – COMMUNICATE

Aviate

Analysis of aircraft accidents over the years often show a similar trend. A very common occurrence is that an aircraft throws up some sort of problem, such as a system failure, confusing indication or other distraction. This problem, whether simple or severe, can then be so distracting to the pilot that it consumes all of their attention. The pilot can easily start to totally neglect the actual hands on flying of the aircraft, which in extreme cases resulted in a completely preventable accident, often all because of distraction from an otherwise harmless problem.

The first step in our system is therefore to Aviate.

This means to make sure that the very first thing we do is to carry on flying the aircraft in a safe way. The effort required to do this can vary massively, depending on what the failure is.

Essentially you need to assess the physical flying state of your aeroplane. The method to do so is often simply continuing or setting straight and level flight. More effort will be needed if dealing with a failure that involves hands on handling, such as encountering windshear or losing an engine in a multi-engine aeroplane.

Focus on the attitude first, and set power as needed. Extreme cases could be a recovery from a stall or unusual attitude. It seems obvious while spiralling earthwards that you need to take action, but it can be far subtler if encountering a less dramatic event.

A realistic example could be after lift-off towards terrain, while your landing gear is jammed down and refuses to retract. Your first reaction might be to notice a red light indicating gear trouble, and try to work out which gear it is. Is the indication correct? Is the bulb broken? Should you try to recycle the lever?

Running through these sorts of troubleshooting steps immediately would be very unwise, as such a distraction would quickly swamp your attention and remove your ability to safely climb away over the terrain in your increased drag state. This is why we always begin dealing with a problem by Aviating. Getting under control can take a various period of time. If a small snag crops up in the cruise, it can take just a moment. However, a sudden windshear encounter or engine failure may take minutes to safely get you back on the rails.

By establishing the aircraft as a stable platform on a safe trajectory, our immediate needs are fulfilled, and we can move on to the next step.

Navigate

Once we have ensured that the aircraft is flying in a safe manner, we need to be certain that we are flying in a safe direction.

This might be to turn away from high terrain, continue on straight ahead in the cruise, or maybe to head towards land. This will depend on the circumstances, but Navigate forms our important second step.

An example of why Aviate comes before Navigate could be a missed approach. We must first enact the go-around by setting full power and retracting flaps. Once a safe climb is established, we can only then concentrate on the missed approach procedure itself.

Once we are under control and flying in a safe direction, we can start to inform those around us that we are having difficulties.

Communicate

After our Aviate and Navigate steps, we need to give an initial heads-up to anyone that might need to know right away, such as Air Traffic Control.

It will often mean a simple Mayday Call, as this will quickly tell ATC that we have a problem and that more assistance may soon be required.

In a larger passenger aircraft, you may make a quick call to the cabin crew, such as announcing "Attention Crew, At Stations" over the PA. Turning on the seatbelt sign would often form a sensible move.

This is not usually the time for a lengthy discussion, but just a quick message to indicate a problem. This can help by giving you some peace and quiet while you deal with a complex system failure, while the cabin crew put away their trolleys and air traffic keep a watchful eye. Communicate forms the last step of our system. They must always be tackled in this order for them to be effective.

Aviate, Navigate, Communicate. By following these three steps, in that order, you will eliminate the immediate risks. An emergency can be very surprising. Having this framework solidly installed into your mind will mean it will be there to help you when things turn sour.

Distress and Urgency

When things do go wrong, it is often necessary to inform ATC as soon as you determine that you need help. After a problem has arisen, this can be done with either a Mayday or Pan call. Which is used depending on the severity of the situation, defined as follows:

Mayday
Distress: Threatened by imminent danger, requiring immediate assistance.

Pan Pan
Urgency: Concern for aircraft safety, not requiring immediate assistance.

Note: An urgency message could also be made on behalf of another vehicle, such as the sighting of a sinking boat.

To initiate a Distress or Urgency message, the appropriate phrase is ideally repeated three times before the message is passed, such as “Mayday Mayday Mayday”. This alerts the air traffic controller that this is an emergency call and will imply to all listening traffic to observe radio silence, in the case of a distress call, so as not to interfere.

To enforce this, ATC may also declare “all stations, stop transmitting”. This radio silence will be in force, except for essential instructions from ATC, until the distress situation has been cancelled by the emergency traffic, by declaring “Distress Traffic Ended”.

An urgency call does not imply radio silence, but other traffic must be mindful to not interfere with the urgent radio calls.

If not in contact with a specific air traffic controller, the same call can be made on the emergency frequency, 121.5 MHz, which is monitored worldwide, when within range of reception.

Speaking slowly and distinctly will help the controller, particularly those with a different native language to yourself, with understanding your situation.

DECISION MAKING

Once we have got the aircraft under control, flying in a safe direction and with air traffic control informed, we can now begin to figure out what is wrong and what to do about it. There is often no single right answer when it comes to how to deal with a particular failure. You are there to make decisions as the commander and how the situation unfolds depends a large amount on how you deal with what is presented to you.

Generally speaking, we need to understand a few things about our predicament in order for us to make the best decision we can.

We need to know:

- What's wrong?
- What do we need to do about it?
- What options are available?
- Which of our option is the safest course of action?

The best way to tackle a problem is often to run through it piece by piece. By being organised, it can greatly simplify the process and enable us to have more spare capacity. This is especially important with single pilot aircraft, as we need to both fly the plane and make the important decisions at the same time.
To organise ourselves, we can use another simple system to help us. There are many different systems out there, and you can develop your own, but here is one of the best:

DODAR

- Diagnose
- Options
- Decide
- Assign
- Review

Diagnose

Careful diagnosis of the situation is worth your time.
After completing our Aviate, Navigate, Communicate process, as we have already discussed, we can now spend some time having a good look at what problems we have.
If we are not clear on what exactly the problem is, we will be basing all our decisions on unclear or possibly misinterpreted information.
We will use as many sources of information as possible to make our best diagnosis.

For example, if we see the engine RPM gauge indicating zero, do we have an engine failure or is it simply a faulty dial? We can see if we are still producing engine power, has the engine sound changed? Do the other instruments agree or disagree with an engine failure?

We will take in as much as we can to find out what has happened. Once we have established this, we can move on to see what, if anything, needs to be done about it.

Options

In order to make a good decision, we should see what options are currently available to us.
Are we near to a major airport? If we have an engine problem, does that mean we can no longer make it over the terrain ahead of us? Make a mental list of your options.
If the failure has been diagnosed to be not particularly serious, we may well be able to continue our flight all the way to the destination. Or if we see we have a pressing issue, we may have to turn back immediately.

In cases where a diversion is required, there are many factors to take into consideration when selecting what airports are available as a viable option. We need to obtain a few basic facts:

- Distance
- Weather
- Landing distance
- Available approaches

These are generally the important pieces of information that need to be processed before we can consider the airport as a safe and reliable option. Looking at these factors in turn, we can run through the process involved:

Distance

How far is the airport from you? The distance to the airport is an important consideration, as it gives an indication as to the time it will take to get there. This is most important when dealing with a serious and immediate threat, such as smoke, fire or fuel leak.

We may well be passing right overhead an airport, which the GPS might display as zero miles. Be aware that zero miles does not mean zero minutes to landing, as you will still have to deal with the problem, prepare an approach and position yourself for landing. Be careful not to discount another nearby airport, which may be more suitable overall.

Weather

Ideally, a professional pilot you should not be taken surprise by the weather at enroute airports. In the cruise, it would be most sensible to obtain local weather reports as you fly, so that you are already in possession of this important information before you need it in a hurry. By operating in such a proactive manner, an important and often time-consuming task is reduced to the minimum time, allowing you to act on this knowledge far faster than inactively sitting there and being caught out.

In scanning through the METARs, (covered in a later chapter) you are just looking for a general picture of the nearby weather conditions. If the report comes back as light winds and clear, then you know weather won't cause you difficulties at that particular option. If you are presented with reports of fog, thunderstorms or high winds, it may mean that this airport is unlikely to be your safest option for a diversion. Not that bad weather means you should rule it out completely, but more investigation may be required and it is entirely possible that all nearby airports have similar conditions. It may become a case of choosing the best of a bad bunch.

Landing Distance

It would be little use to dive into a nearby, clear airport to then run off the end of the runway after landing. Knowing that the landing distance is long enough for your aircraft in its current state is important and it is well worth aiming for a good safety margin.

Failures can increase your required landing distances dramatically, sometimes double or more. To work out an exact figure would be time consuming, so if a long runway is available, it should be carefully considered.

Available Runways

In the event of a failure that requires a prompt diversion, you are looking for a reliable option. Multiple runways at an airport increases its reliability greatly, as racing towards a single runway airport in an emergency exposes you to great difficulties should that one runway be closed. it would not take much to do this, an aircraft with a blown tyre, the discovery of surface damage, snowfall, flooding, other emergency traffic or even pre-planned maintenance work currently underway. Having two or more runways available to you is of great benefit.

Gathering options while accounting for these factors can take various lengths of time. One of the best defences to getting caught out is to gain familiarity with the airports you fly over. By already having a rough idea of an airport, you can use that knowledge in a flash should a problem occur. For example, flying through central Spain, having some knowledge of Madrid, with its precise ILS approaches and multiple runways, we already know this airport is likely to be a good option, probably only prevented by hazardous weather.

Taking account of a few nearby airports and considering these factors, we can quickly acquire a handful of options to choose from. There may be no perfect option on the day, but efficiently processing the facts will give the best options for consideration and will prepare you for the next step in our DODAR process:

Decide

Once we have established a few options that are open to us, we can now decide which of them is the safest course of action. The safest option may well be to continue a little longer in order to reach your original destination. With a plane full of passengers, if a medical situation arises, it may not be worth the risk to dive into a nearby airport that is covered in thunderstorms. The ill passenger still needs urgent attention, but the other passengers and crew also need to be kept safe. It may be an uncomfortable decision in the heat of the moment, but if no safe option is available, it would be irresponsible to disregard the safety of all the others onboard.

However, deciding to continue to your destination should not be taken lightly. Is the engine running rough because of a magneto failure? If your flaps are extended and jammed in place, do you have enough fuel to carry on?
If we have just taken off at night and have an electrical failure, we might be difficult for other aircraft to see as our lights have failed. Is it worth the risk to carry on?

Many factors can be at play, such as aircraft capability, terrain, closed runways, bad weather and so on. It's down to you to use your best judgment to ensure you make the best decision under the circumstances.

Assign

When you have settled on your safest course of action, it is time to begin putting your plan into motion.
This step is simplified when you have other crew members to help you, as you can assign them tasks to complete in order to ease the load from you, the captain.

For example, if you have a co-pilot you can ask them to do the hands-on flying, which will free your mind up, making your decisions easier to make.
If you are flying solo, you will have to be organised in order to get all bases covered.

It may be useful to use the "Four C's" to aid your memory:

- Controller
- Cabin
- Cockpit
- Company

Controller

ATC need to know what your plan is, so tell them as soon as you have made a decision. Once they know where you need to go, they can give you directions to help you get there, to get you on your way to a safe place as soon as possible.

ATC can be of great help. They can make arrangements such as calling an ambulance to meet a sick passenger, have the airport fire services prepare for your arrival, or provide you with radar vectors to help you navigate to an airport. By talking with air traffic early on, you give them time to make arrangements and you can start flying towards your diversion airfield, while you complete your other tasks.

Cabin

Most applicable on large aircraft with cabin crew and passengers. If you have cabin crew, they need to start getting things ready quickly, so give them the time they need.
A common way is to use a set format, such as the NITS Brief, as detailed below.

Once you have told ATC and informed any cabin crew of your plan, you should briefly inform any passengers you have onboard what has happened and what you plan to do about it. Flying is the source of great fear in many people and being left in the dark during a serious problem can spark panic and distress. Just a few words can be settling them and keep them relatively calm until safely on the ground, where more information will be passed to them.

Cockpit

You can now begin to prepare the aircraft for landing.
Depending on the circumstances, this step may contain running through checklists, calculating landing distances or programming the flight computer. Whatever needs doing for your circumstances, this is a good time to do it.

Company

Although a relatively low priority during an emergency, a professional pilot should take a moment to inform their employer about where he is taking their aircraft. Sometimes the biggest problems occur after landing, where passengers are stranded on a diverted aircraft, with no steps to disembark, no ground staff to help and no transport or accommodation arranged. Informing the company before arrival can ease what can become a logistical nightmare.

NITS Brief

As a method for organising communication during times of stress, airlines often use a set format for communicating emergency procedures to the cabin crew.

One such system is:

NITS
• Nature • Intentions • Time • Special Instructions

Nature
What is the nature of the problem? Explain In a few words what has happened. Such as “we have a hydraulics problem” or maybe a “smoke indication”. Keep it simple as the cabin crew will not have the same depth of knowledge about your aircraft as you do, especially for complex failures.

Intentions
What are you going to do? State your intentions clearly, such as “we’re diverting to Toulouse” or “We’re turning back to stand”.

Time
How long until landing? If landing is expected in just a few minutes, the crew will adapt and do just the bare necessities of ensuring the cabin is in a safe state for landing, such as seat belts fastened and trolleys secured. If you are far from the airport, they can use their time to make an emergency briefing to the passengers, demonstrate life jackets and offer more assistance. Give your best estimated time of landing.

Special Instructions
Normally these instructions are to prepare the cabin for a precautionary or emergency landing, but it could contain any other instructions. As opposed to a precautionary landing, an emergency landing implies it is possible that the landing may be rough and followed by an evacuation. This is when a “Brace Brace” call might be used.

Review

The last step of DODAR is to review your plan. You have made the best decision you could, based on the information available to you. But do you now have new information that might require you to change your plan?

You can always change your mind if the situation changes. A co-pilot could be very useful as a second opinion and can be used at any stage. For solo flying, now is the time to run through your plan and make sure it is still the right course of action, to the best of your judgement.

For a multi-crew operation, now would be a prudent time to make an approach briefing. By covering the Weather, Aircraft State, NOTAMs and Threats, you will bring your co-pilot up to speed with the plan, and you will also get valuable input from a second opinion.

Summary

We have now diagnosed what the problem is, determined what options are available, decided on the safest course of action, assigned tasks to put your plan into effect and have now reviewed your decision, to make sure it is still the right thing.

Using the DODAR system, we have a format to follow that can help us make the best decision, no matter what occurs.
You can always change your plan, and there are often air traffic controllers or other crew that can help you along the way, but it is your decision and you need to be as sure as you can be that you are doing the right thing.

Strike a balance between taking your time and not causing undue delay. The severity of the situation will dictate this, as a fire onboard will need immediate and rapid action, whereas a more minor fault needs to be looked into carefully to avoid a misdiagnosis.

Whenever we have an issue, first Aviate, Navigate and Communicate. This will keep us flying safely. Then decide on what to do with DODAR. We can use this system in any aircraft, big or small, to help ensure a safe outcome should the unexpected happen.

THE COMMANDER

The commander of an aircraft is the pilot responsible for the safety of the aircraft, its cargo and everyone on board. There is only one commander on a flight, which is different in definition to a captain. Captain is a rank, such as First Officer or Sergeant, whereas a Commander is the person tasked with the authority and final responsibility for safety.

There is always a Pilot in Command (PIC). There may be any number of captains, even none at all. For example, when flying a light aircraft solo, you are the PIC, but you do not hold the rank of captain.

Authority & Responsibilities

There are a multitude of rules, regulations and procedures that must be satisfied in order to conduct a flight in a safe and legal way.

As the commander, you are responsible for ensuring that your flights can be completed safely and in accordance with the many regulations intended to keep the travelling public safe.

While a multitude tasks must be completed before flight, it does not imply that the commander must complete each of them personally. The various tasks are delegated to members of the aircrew and groundcrew, in preparation for the final approval from the captain. By running through each of these requirements in turn, we can cover a wide range of knowledge that will prove essential to a commander.

Some of the most pressing requirements to be satisfied are listed below:

- Safety of all crew, passengers and cargo while he is present onboard.
- Safety of the aircraft while the engines are running.
- Ensure that passengers receive a briefing on the locations of emergency equipment and exits
- Ensure that company SOPs and procedures are adhered to.
- Deny carriage of any person or cargo likely to negatively impact flight safety
- In an emergency, take any actions and decisions, including those that deviate from rules and procedures, to ensure the safety of the flight.
- Decide whether to accept an aircraft that has defects or unserviceable equipment
- Ensure the correct operation of Flight Data Recorders and the safekeeping of the recordings after an accident or incident.
- To disembark any person or cargo that presents a potential hazard to the safety of the aircraft or its occupants.
- Ground facilities and services are available at destination
- The correct quantities of Fuel and Oil is carried
- Any cargo is loaded and secured correctly
- Minimum Flight Altitudes are adhered to

This list is not exhaustive, but covers the most pertinent tasks and responsibilities that the commander must be familiar with. Tackling each in turn, we'll discuss the various requirements and how they are dealt with.

Disruptive Passengers

There are millions of people across the globe taking flights each year. For one reason or another, some of these people will present a hazard to flight safety. Disruptive passenger incidents

There are a multitude of ways this could happen, from disgruntled passengers, long delays, lost suitcases drug use and alcohol consumption.

On the ground, the Captain has the authority to deny carriage of any person they deem hazardous to the safety of the crew, other passengers or the aeroplane itself. Cases where it would be reasonable to offload a passenger include:

- Drunkenness
- Disobedience towards crew instructions
- Persistently threatening, abusive or insulting behaviour
- Interference with crew safety duties
- Hoax bomb threats
- Committing a crime at the airport

Once inflight the situation is to me managed as the Commander sees fit, given the circumstances. The level of severity can broadly be divided into four categories:

Level 1	Verbally Aggressive, Disorderly
Level 2	Physically Aggressive, Causing Damage
Level 3	Life Threatening Behaviour, Weapons
Level 4	Attempt to breach cockpit door

If cabin crew are present, they will attempt to contain the situation by using verbal de-escalation techniques. Physical intervention is not to be used unless absolutely necessary. Sedatives are never to be administered.

Flight crew are not to become involved in aggressive behaviour inflight. If the situation becomes violent, an injured flight crew member potentially presents an even greater risk to flight safety. Level 3 and 4 incidents are to be reported to ATC. If it is considered unsafe to continue, the flight should be diverted and the offending person(s) will be met by local authorities after landing.

With disruptive incidents becoming increasingly common, the Captain must be ready to exercise their authority and maintain the safety of the aircraft and all those onboard.

If difficulty or violence is encountered while dealing with disruptive passengers, airport security or local police are usually on hand for a rapid response.

Dangerous Goods

As many air travellers will know, there are restrictions on what can be carried in passenger baggage. Apart from the obvious hazards such as explosives, many common household items are also prohibited on safety grounds.

Forbidden items include anything which during transport is liable to explode, react, produce a flame, get dangerously hot or produce toxic, corrosive or flammable gasses.
This covers a huge number of otherwise typical and everyday items, so there is a system of exceptions and procedures to be followed to allow carriage onboard.

Exceptions include any items that are required for the operation of the aircraft or the health of passengers and crew, such as equipment batteries, fire extinguishers, exit signs containing tritium, first aid kits, escape slide inflators, insecticides and so on.

Also, items for sale onboard as part of an inflight service are excluded such as some aerosols, perfumes, alcoholic drinks and portable electronic devices containing lithium batteries (if they meet certain requirements) and dry ice for food storage.

Medical provisions for passengers are allowed, including medicines, drugs and gas canisters. Some specialist items are only allowed if the user is properly trained in using the item correctly.

Some goods may be carried if certain measures are taken, such as an electric wheelchair with an onboard battery. In this case the battery would be removed from the chair and stored in a specially designed container that ensures the battery terminals are properly isolated.

Many items are safe to transport as long as they are inaccessible inflight, such as a hammer or baseball bat. While other items are only deemed safe if they are immediately accessible, such as cigarette lighters and safety matches.

In some cases, the captain must be informed when a particular item will be carried, such as sporting rifles and electric wheelchairs.

Crew are trained to handle a dangerous goods incident, such as a corrosive liquid leaking from an overhead locker. The captain will likely commence a diversion while the cabin crew don protective clothing and do their best to contain the spillage and prevent dangerous vapours from circulating.

Dangerous goods can be carried by many cargo operators, while passenger aircraft usually prohibit them. The information needed will be contained within the airlines manuals, with all the associated procedures.

MEL

Modern aircraft are very complex machines with long lists of fitted equipment and systems. As with other complex vehicles, it is unlikely that absolutely everything will be found to be in perfect condition and fully functioning.

Thankfully, perfection is not required for a safe flying machine. There are items that can be broken, missing or otherwise unserviceable will not impact the safe conduct of the flight in any meaningful way, while others will have the aircraft grounded until the problem can be properly rectified.

Imagine a road car with a flat tyre. It is clear that driving off with a flat would be unsafe and cause further damage, so this would be a no-go item. However, if the cigarette lighter or CD player is broken, there is no effect on the roadworthiness of the car and you could drive it perfectly safely until you get the opportunity to have it fixed.

This same logic applies to an aircraft, with each unserviceable item having its own level of severity and implications. The document produced by the aircraft manufacturer to determine serviceability is the Master Minimum Equipment List (MMEL).

From this MMEL, the airline or company that operate the aircraft creates its own Minimum Equipment List (MEL) which must be at least as restrictive as the Master upon which it was based.

Let’s say that during our pre-flight checks we notice that our green nav light on the right wing is broken. This does not necessarily mean the aircraft can’t be flown, so we refer to our MEL. In there we would likely find that we may fly, but only during daylight hours, and that it must be fixed within 10 days.

We can have multiple inoperative items, often as long as they do not compound a problem or influence each other.

CDL

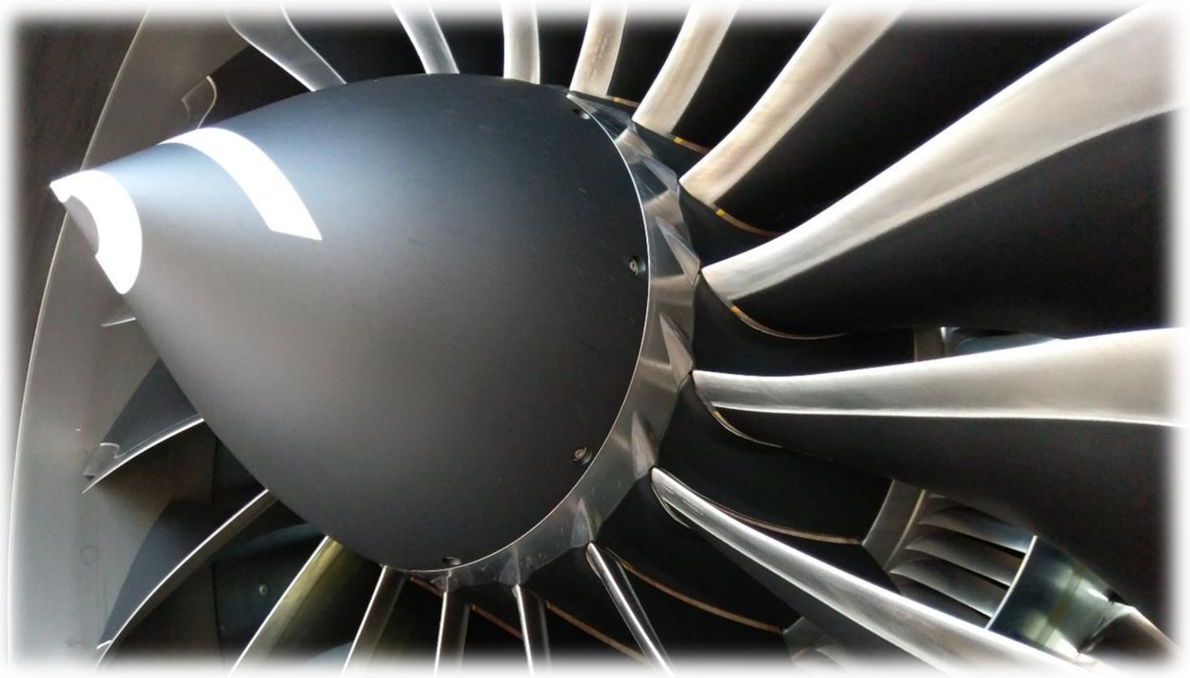
For exterior items such as bodywork, static wicks, panels and covers, another list is used. The Configuration Deviation List (CDL) contains which pieces may be missing or damaged for the flight to be continued. Exterior defects often come with performance implications, as the aerodynamic efficiency may have been reduced. This is typically in the form of an increase in fuel burn, particularly for any defect to a leading edge, such as along the front of a wing.

By ensuring that any defects are acceptable under the MEL or CDL, the captain can be satisfied that they can safely dispatch with the aircraft in its current state. Any further technical issues that arise will have to be dealt with and the MEL/CDL consulted. Once the aircraft has first begun to move under its own power it is considered to have “dispatched” and the MEL/CDL no longer apply. After dispatch, technical problems are to be assessed by the captain and handled how they see fit.

FUEL PLANNING

The captain is responsible for ensuring a safe fuel level for each flight. You must take account of weather, delays, alternate airports and other factors, so let's look into how we arrive at a fuel figure.

To use as an example, we will consider a flight from London Gatwick to Tenerife in a typical twin-engine jet, the A320.



Each aircraft has its own fuel consumption, we will use the very popular Airbus A320 throughout this section as an example.

Each part of the flight has its own fuel requirements, each of which are calculated individually and then totalled. Here are the various stages of flight and external factors we consider so that we can calculate a safe fuel figure.

- Taxi
- Trip
- Contingency
- Alternate
- Final Reserve
- Extra

Taxi

Included in the Taxi fuel is all the fuel you plan to use between starting the engines and getting to the runway for departure.

The A320 consumes 100kg per 10mins of taxi. How long it will take to reach the runway varies massively from airport to airport so this should be considered carefully. For example, leaving Liverpool might only take 10mins, but taxiing around Amsterdam can take anything up to 30mins, longer than the flight itself in some cases. Start-up and Taxi to runway 26L in Gatwick is calculated to take about 200kg, roughly 20mins. However, this is a busy airport and delays are common, so it would be sensible to add extra time in case you are in a queue at the holding point. An additional 20mins will cover it. 20mins is 200kg, added to our baseline of 200, gives us a taxi fuel of 400kg.

Trip

So, we have made it to the runway with the use of our taxi fuel. Trip fuel is the fuel used for the rest of the flight to get us from A to B if everything goes to plan. It covers takeoff, climb, cruise, descent and landing at our destination. For Gatwick to Tenerife, we expect this to take around 4 hours. Our A320 uses about 2400kg per hour, giving us a trip fuel of 9600. Trip fuel will be calculated with the wind taken into account, as a headwind would slow our progress and so require more fuel, for example.

Of course, if taxi and trip fuel was all we took, we would arrive at our destination with empty tanks. This is not a sensible idea, obviously, so the regulations have us add a few more factors to our fuel figure.

Contingency

Our trip fuel was calculated with the best information available at the time, but in the real world, this is rarely entirely accurate. We need a safety margin to account for unforeseen circumstances, such as a tailwind not as strong as we had hoped, or having to avoid storms enroute that were not forecast. This margin is our contingency fuel and is 5% of the trip fuel, to a minimum of 5 minutes. So, for our case, 5% of our 9600kg of trip fuel is 480kg.

Alternate

Usually a flight will need a plan B in case we encounter a problem on arrival and need to divert. We need to take fuel to get us from the missed approach at the destination to a landing at our selected alternate airport, in case something means we can no longer continue to land at our destination. This could be a closed runway, thunderstorm overhead, aircraft accident or any number of other possibilities.

As discussed later in the section on Alternate Airports, we typically need a backup airport, and this means we need fuel to get there. Alternate fuel takes us from initiating a go around, following the full missed approach, then flying to and landing at our alternate airport.
In our example, a good nearby alternate to Tenerife South is Gran Canaria. It would take about 30mins to divert, burning 1200kg in our A320. So, our alternate fuel is 1200kg.

Final Reserve

We now apply another important safety margin, known as Final Reserve. No matter the circumstance, the rules state that we must never land with less than our final reserve fuel. For jet aircraft we require 30mins of holding fuel, whereas propeller driven aeroplanes require 45mins.

For calculation purposes, this is defined as 30mins flying time while holding overhead the alternate airport at 1500ft in standard ISA conditions at the planned landing weight.

Holding for 30mins in these conditions will cause our A320 to burn around 1200kg, so this is our Final Reserve figure.

Extra Fuel

Our calculations so far have accounted for most unforeseen circumstances such as wind changes, weather avoidance and diversions. However, if a problem is foreseen, the captain has the ability to add fuel to absorb this without eating into other areas of his fuel planning. A typical example could be holding at destination. If it is commonplace to arrive at an airport and then hold for a significant time, this needs to be included in your fuel figure. Another reason might be expected runway changes, longer routings, foggy conditions or snow clearance.

For our mid-summer flight to Tenerife South we see it quite possible that we may encounter some holding or short delays as we reach our destination, so the Captain can elect to add fuel to absorb this eventuality.

Our A320 will burn around 400kg for approx. 10mins of holding, so we will add this to our calculation and we will arrive at our final fuel figure:

Taxi	200
Trip	9600
Contingency	480
Alternate	1200
Final Reserve	1100
Extra	400
Total	12980 kg

Oil Consumption

All aircraft engines use oil, so ensuring the right amount is onboard before departure is another task for the commander.

A typical minimum level would be a baseline figure plus expected oil consumption. A typical Airbus A320 needs to leave with 9.5 quarts plus 0.5 quarts per hour of planned flying.

Topping up the oil level is typically an engineering task for larger aircraft, whereas a light prop will usually have its tank dipped and lubricant replenished by the commander pre-flight.

Fuel Tankering

Aeroplane operators are always looking for ways to make their flights more efficient and cost effective. When dealing with fuel planning, a common technique to employ is “Fuel Tankering”.

Most motorists will do their own fuel tanking on a regular basis. It is so common as it follows the simple logic of “fill up where its cheap”. If you find a petrol station with a good price for your fuel, you may as well fill the tank. This is roughly the same case with aircraft.

Taking a large fuel load does have disadvantages, as by increasing the weight of the aeroplane, more drag is produced inflight, meaning you are less efficient. It is therefore calculated beforehand whether the increased enroute fuel burn is worth the trade-off versus the low price.

Also, the aircraft weight limitations must be taken into account, as it would be foolish to load up with fuel, only to discover enroute that you are too heavy to land at the destination. Perhaps also you are planning a long flight in particularly low temperatures, which can cause the fuel to drop to very low temperature and cause icing or fuel temperature issues.

Contracting issues can also be a reason to tanker. After these factors are considered, if the calculation comes up with a positive answer, tankering can be an effective cost saver.

AIRCRAFT LOADING

An aircraft only has a limited weight capacity for carrying cargo. The weight and balance of the aeroplane can make a huge difference on its handling and performance, so any cargo must be within weight limits and correctly loaded.

If too much weight is loaded, the aircraft will not meet its performance requirements or could suffer structural damage. If the load is not balanced properly, it may cause drastic effects such as the impossibility of recovering from a stall or spin or not enough rudder authority to survive an engine failure.

An improperly secured load could move inflight and push the aircraft balance beyond its limits, which has caused aircraft accidents several times throughout aviation history. For example, if a load slides backwards towards the tail after takeoff, the rearward movement of the Centre of Gravity will pull the nose up, while there may not be enough power in the elevators to prevent this, resulting in a low speed, low altitude stall without the control to push the nose down to recover.

When considering weights, there are various terms to cover the many different ways that an aircraft weight can be reported. Note that while weight and mass have different definitions from a physics standpoint, they are used interchangeably when dealing with aircraft. Here are how the most common weights are defined:

MEW Manufacturers Empty Weight

The weight of the aircraft structure, engines, furnishings, systems and other equipment that are considered an integral part of the aircraft. It is effectively a “dry” weight, as only the fluids contained in “closed” systems such as hydraulic fluids are included.

OEW Operational Empty Weight

The MEW plus the operator’s items which include the Crew and their baggage, unusable fuel, engine oil, emergency equipment, toilet chemicals, documentation, galley structures, catering trolleys and passenger seats.

DOW Dry Operating Weight

The OEW plus items required for that particular flight such as catering and any extra crew members.

ZFW Zero Fuel Weight

DOW plus Traffic Load.

MLW Maximum Landing Weight

The maximum allowable landing weight in normal circumstances. It is often possible to land ‘overweight’ if certain procedures are followed, depending on the aircraft type.

MTOW Maximum Takeoff Weight

The maximum allowable weight at the commencement of the takeoff run. This is normally listed in the AFM as an absolute limit, however as airways charges are broadly based on MTOW, some operators will artificially lower their MTOW to a lower value to reduce costs.

Traffic Load

The combined weight of all passengers, baggage and cargo, including any 'non-revenue' loads such as spare aircraft parts.
Passenger weight is determined by application of various 'standard weights', rather than asking individuals to step onto the scales. Including their hand baggage, passengers are assumed to weigh as per the following:

Male Adult	93 kg
Female Adult	75 kg
Child (<12)	35 kg
Infants (<2)	0 kg

Hold baggage is based on actual weight and this is determined at check in.

If needed, the Captain always has full authority to make changes to the aircraft loading such as passenger numbers and the distribution of baggage and cargo between cargo compartments.

Weight and balance is to be carefully plotted and checked before departure and is the responsibility of the commander to ensure all limitations are satisfied.

MINIMUM FLIGHT ALTITUDES

It is the responsibility of the Captain that the aircraft is not allowed to be flown below any particular MFA except for the purposes of Takeoff and Landing. The purpose of most minimum altitudes is to avoid conflicts with terrain and obstacles, but can be put in place for airspace requirements or navaid reception limitations, amongst others.

These altitudes are absolute minimums and are to be increased depending on factors such as temperature changes, air pressure and wind speed. ATC will not necessarily include such adjustments in their clearances, so knowledge of these MFAs is important.

There are a few different ways of determining the MFA for a particular moment, so we'll touch on each of them in turn.

MSA

Minimum Sector Altitude

Within a 25nm radius of an airport or navigational aid, 1000ft clearance is given above the highest terrain or obstacle in that area, giving the MSA.

This 25nm area can be divided into sectors with each sector allocated its of MSA, to account for high terrain in one particular zone nearby the airfield.

MORA

Minimum Off-Route Altitude

For a particular route, an area 10nm each side of the route centreline is considered for terrain and obstacles. 1000ft margin is given above surrounding terrain that is no taller than 5000ft. For higher terrain, a 2000ft margin is applied.

MGA

Minimum Grid Altitude

An enroute chart is divided up into a grid pattern, with each grid square defined by lines of latitude and longitude. The highest terrain or obstacle within each grid square is taken and has a safety margin applied to it to define a minimum safe altitude. The margin varies slightly depending on the chart producer, but is generally 1000ft for terrain up to 6000ft, and 2000ft margin above terrain exceeding 6000ft. In some regions, including parts of France, airspace and danger areas are also considered as obstacles for this calculation.

SYSTEM FAILURES

Radio Failure

Aircraft are under the control of ATC for most A to B flying. In today's busy skies it takes great coordination to keep aircraft safely separated, so if a radio failure occurs, it has the potential to cause chaos.

Having standardised procedures to follow makes this rare event much more organised and reduces the risk to other aircraft.

The majority of lost comms cases are caused by human error such as accidentally tuning to another frequency. The first action in these cases is therefore to look for any "finger slips". It is very unlikely that all onboard radios have ceased to function, except in the cases of serious electrical malfunctions.

Check all the radios to see if you can get through. Try all available microphones and other headsets. This will fix the majority of communication problems. If none of your experimentation works, begin to apply the Lost Comm procedure:

Set Transponder to 7600. This will show to ATC that you are aware you have a radio failure. Try to make contact on frequency 121.5, as this is the international distress frequency and is monitored worldwide.

VFR Flights

- Stay clear of cloud
- Land at the nearest suitable airport.
- Report your arrival to ATC by phone

IFR Flights

- Maintain current Speed and Altitude (or MSA if higher) for 7 minutes.
- Continue enroute to the airport navaid.
- Hold at the navaid until your original planned ETA.
- Make a normal approach.

Just because you can't hear ATC, doesn't always mean they can't hear you. In case your radio receiver has failed but the transmitter is still operative, it is worth making "blind" radio calls, in case someone can hear it. Report what you are doing, including the additional phrase "Transmitting Blind" in your call.

When nearing the airport, ATC may be able to provide information via light gun signals from the control tower:

Steady Green	Cleared to Land
Flashing Green	Land at this airport (Followed by steady green)
Steady Red	Await landing clearance, keep circling
Flashing Red	Airport not safe, do not land here
Alternating Red/Green:	Beware of extreme danger

On approach, this basic form of communication can provide either a final confirmation that landing is permitted, or an instruction not to land as the runway is not safe. If a steady red signal is displayed, it indicates that you may continue to circle, bit it is not yet safe to land. If you come across this signal, you are unlikely to be able to determine what is causing the delay and consideration should be given to diverting to another airfield if you are beginning to reach low fuel levels.

A form of reply can be sent by the pilot, if possible, by flashing on and off their aircraft lights. This will indicate to the tower controller that the message is understood. It is not expected during a critical stage such as landing, but can give a clear confirmation that communication has been established.

In some places pyrotechnics such as flares may be used in place of light signals. The colours used will be the same and have identical meaning.

Unreliable Airspeed

Airspeed is a very important parameter to have displayed. When a problem occurs that causes an unreliable indication, confusion can creep in. To understand how an airspeed indicator can be impacted, let's briefly review how the instrument works.

An Airspeed Indicator has a sealed capsule at its centre, in a similar way to an altimeter (as discussed in the Altimetry section).

Whereas an altimeter only measures Static Pressure, an airspeed indicator has two inputs:

Static Pressure
In an identical sense as an altimeter, the airspeed indicator is fed with the current outside air pressure by a port called the Static Port. These must be shielded from the airflow, otherwise changing speed may change the pressure reading.

Dynamic Pressure
When driving in a car, try putting a hand out of the window. If travelling at speed, your hand will be pushed back by the oncoming air. This force gets stronger as speed is increased. This is dynamic pressure.

One or more pitot tubes are fitted to the aircraft, facing forwards into the airflow. As the speed increases, more pressure is registered by the instrument, which is calibrated very precisely to convert this pressure into an indicated speed.

As you climb, pressure reduces. Static pressure is fed into the instrument to account for those altitude changes.

To safely recover from an unreliable airspeed situation, remember a simple fact of aviation:

PITCH + POWER = PERFORMANCE

If you can set the right pitch and power, the aircraft will continue to obey the physics it always does and the same result will be achieved each and every time.

If your airspeed indicator appears unreliable, first set a climb pitch and power setting, reach a safe altitude such as MSA, then level off for diagnosis. To level off, set a normal cruise pitch and power.

A blockage or obstruction of a pitot or static system would affect the instrument in different ways:

Static Blocked

With no supply of static pressure, accounting for altitude cannot be done, so as the aircraft climbs and the pressure decreases, this will be felt as a reducing dynamic pressure, indicating as a reducing speed. Unless the altimeter has a separate source, a blockage of the static port will simultaneously cause the altimeter to freeze its current indication.

Pitot Blocked

Removing the dynamic input from the instrument leaves only static pressure, which is identical to a simple altimeter. As such, the airspeed indicator will behave like an altimeter. As you climb, the indication will increase, as you descend, the indication will decrease.

Volcanic Ash

In the event that a volcanic ash cloud is encountered, you may experience some or all of these symptoms:

- Electrical burning smell
- Hazing in the cabin
- Pitot blockage
- Static discharges and sparks
- Engine surging
- Scratching/Hazing of windscreens

If you have a strong suspicion that Volcanic Ash has been encountered, the following steps should keep you safe:

Turn Around
Making a U-Turn is usually the quickest way out of an ash cloud. A cloud could potentially extend for hundreds of miles.

Notify ATC
Informing ATC of your actions and the presence of an ash cloud will allow them to direct traffic away. Static electricity may cause radio interference, making communication difficult or temporarily unavailable.

Control thrust manually
Engine power may surge and begin to vary, disengaging any auto throttle will help keep a constant power setting.

Use crew oxygen masks
The cabin air will likely be becoming contaminated by fine ash particles, using any supplementary oxygen supply available will protect your breathing.

Turn on engine and wing anti-ice
Increasing the air bleed demand from the engines will give larger margins before they stall and shutdown.

Monitor Engine parameters
Engine indications, particularly exhaust temperature, may rise to dangerous levels. It may be best to shut down the engine as a precaution, before restarting once clear of the cloud.

Monitor Airspeed
Ash will likely clog the pitot tubes, causing airspeed indication errors, as discussed earlier in the unreliable airspeed section.

RULES OF THUMB

Flying can get complicated. To help you ease the load, there are a range of helpful quick calculations to help you out. Let's have a look at the ones you can use on a daily basis.

DISTANCE TO HEIGHT **DISTANCE x3**

This is probably our most used rule of thumb. It works for long ranges, such as when to begin a descent from cruise altitude, or to check your progress as you near the beacon.

In light aircraft then this rule is basically all you need. For larger aircraft with higher inertia, you also have to account for the distance it will take to reduce speed. In most practical terms, this means 'adding a bit', such as 5-10nm, to your distance.

3 DEGREE DESCENT **GROUNDSPEED x5**

Easily worked out and highly useful, the Groundspeed x5 rule also works at long or short ranges. If we had a strong tailwind on approach and did not adjust for it, we would be covering ground more quickly, so our rate of descent would still take us down the glideslope in the same amount of TIME, but as we have travelled further in that time, we might have overshot the airport! Basing our rule on groundspeed solves this problem and takes account of any head or tailwind.

RATE 1 TURN **10% AIRSPEED +7**

With a small aircraft like the Cessna 172, you will be flying pretty much everywhere at almost the same speed, typically 100 knots or so. Once you work out that 17 degrees of bank gives a rate 1 turn, you will use this number over and over. Also, you are assisted by the turn co-ordinator, which indicates rate 1 turns when a wing is touching a 'block' on the dial.

For larger aircraft, which have no turn co-ordinators and go through significant speed changes throughout a flight, you will be calculating for a few different speeds. If your answer comes up at more than 25 degrees of bank, disregard your calculation and just use 25 degrees, as this is considered the maximum bank angle for flying procedures. In the cruise, rate 1 turns are a little excessive for passenger comfort, so make your turns earlier and with more like 10 degrees bank when cruising in an airliner.

TURN ANTICIPATION 1% GROUNDSPEED

Most useful when a large turn is required, using 1% of your groundspeed is best suited with medium-large aircraft. Throughout the missions you will fly, try to calculate when to turn, but remember that this will be very conservative in the little Cessna unless a very large change of direction is required.

LEVEL OFF 10% VERTICAL SPEED

Mostly of assistance in smaller aircraft, using 10% of your vertical speed can give you a smooth, controlled and comfortable level off. Airliners typically use Flight Directors on their instruments to guide you even more gently, but this feature is usually not found on smaller aircraft.

Be aware that ICAO stipulate some restrictions on vertical speed. In European airspace, if there is traffic nearby as you reach your desired altitude, they impose a limit of 1500fpm for the last 1000ft of climb. The UK have slightly different rules, where you are to reduce your vertical speed to 1500fpm earlier, for the last 1500ft of climb. They also impose a minimum rate of 500fpm in controlled airspace. The FAA impose different rules again, so for maximum realism, look into the restrictions in place for where you intend to fly.

There are more of these quick calculations out there, but we are covering the important ones for our purposes. They all get easier with practice.

AIRCRAFT SYSTEMS

To be in charge of any heavy machinery, the operator should have a good working knowledge of the various systems involved. This is very true when it comes to an aeroplane, as help is usually far away and the captain is the authority at the scene.

This is not to say that knowledge of every nut and bolt is required nor expected. We have only a finite capacity and should be seeking balance of all areas as opposed to a master of one.

The Classic airliners of the past had 3 flight crew members. A captain and first officer, as today, but also an engineer. These aircraft needed three crew as they were much less automated than the aircraft of today. Arguably they were not much more complicated, as such, only that they required more manual intervention. Where an engineer would have controlled the pressurisation system manually, for example, practically any airliner today will have one or more computer managing the task.

In the event of an emergency, the workload could be easily divided between the 3 crew. An engineer to work through the failure, adjusting settings and completing checklists. The first officer would have the sole purpose of manual flying, and the captain for everything else, including deciding on the right plan of action, given the circumstances.

Today, you are a crew member down from the outset, with just 2 pilots at the controls. The aircraft may be more automated, but these systems can and do malfunction. Computerised aircraft also have the effect that often a single failure can affect several systems and often in complex and confusing ways.

The progress made over the last few decades has of course made aircraft more reliable and easier to use, but you should be under no false senses of security.

Each aircraft has its own quirks and special cases that you need to know about. In modern aircraft such cases could be an awareness that the computer may simply be telling you misleading information and to blindly follow could have dire consequences.
As an example, with the Airbus A320, let's say you encounter a flock of birds just after takeoff. A bird goes down each engine. Engine 1 is still producing thrust but has a fire, whereas engine 2 has been more seriously damaged and has failed completely. The computers will sense these occurrences and will display them to the pilot. However, the system is set up in such a way that an engine fire is considered more serious than an engine failure. The most pressing issue, in the eyes of the computer, is therefore the fire and so will be at the top of the list. The system will instruct the pilot to shut down the engine on fire, but let's think about this. Engine 1 may be on fire, but it is your only source of thrust at this moment, as engine 2 has failed completely. If you shut down engine 1, yes you may put the fire out, satisfying the computer but you have just shut down your only running engine.

Blind conformance to a computer's instructions, in this example and many others, can have disastrous results. Know your aircraft and its quirks.

A technical course covering particular aircraft is obviously outside the scope of this course, but many resources are available online for almost any aircraft you might have an interest in.

While studying, avoid getting into too much nitty gritty details, as these are unlikely to be of any real help, even in an emergency, and may take your eye off the ball leading you to under-perform in other areas.

SPEEDS

Every aircraft has its own set of limitations, which are essential knowledge. Many of these are in the form of speed limitations, so we'll run through some of the more relevant terms you will come across.

Speeds are usually shortened with a system of "V speeds", V standing for velocity.

VFE

Each aircraft with high lift devices, such as flaps and slats, have speed limitations for their use. VFE is the maximum airspeed for that configuration. An exceedance would have to be reported to engineers, so they can inspect for damage, before the next flight.

VMO

This is the maximum airspeed for normal operations in the clean configuration, such as in the cruise. Considered a limit, there is a safety margin built into the design, so structural damage is unlikely, but again an exceedance would need reporting and inspecting.

VNE

Treated much the same as VMO, VNE is the Never Exceed speed and is different to VMO in that damage is likely to occur. An airliner would use VMO as its limit, whereas a small single engine aircraft would typically refer to VNE.

VMCA

The minimum speed for multi-engine aircraft at which directional control can be maintained with one engine failed with the live engine at full power and 5 degrees of bank towards the live engine.

For multi engine aircraft, an engine failure will cause a strong yawing motion, as the total thrust will no longer be symmetrical.
To counteract this yaw, the rudder is used to keep the aircraft flying straight ahead.

As the rudder is a control surface, it requires an airflow over it to be effective. With full power on the live engine, the rudder needs a certain amount of airflow over it to provide enough power to keep the aircraft straight.

The minimum airspeed at which the rudder has sufficient power is called the minimum airborne control speed (VMCA).

If the speed was allowed to drop below this minimum, the rudder would not have enough aerodynamic force to counter the asymmetrical thrust, and the pilot would begin to lose control. This is a very important limitation for handling an engine failure, so VMCA is marked on most airspeed indicators with a blue line.

If airspeed drops below VMCA, the recovery is slightly counter intuitive. In most cases you would increase thrust to increase airspeed, but as we are below VMCA, the thrust is causing a control problem, so unlike other cases, thrust should be slightly reduced and the nose lowered to regain airspeed. Speed is to be prioritised, so if at your current weight and altitude you are finding speed impossible to maintain, begin a descent to stay above the blue line. Making a small bank of 5 degrees towards the live engine will also offload some of the demand from the rudder, assisting handling.

Aircraft have a whole range of other limitations, such as maximum altitudes, weight limitations and brake temperatures, to name a few. These are the things that a captain would need to know and would be covered in a type rating course.

AIRPORT FACILITIES

PAPI

Runways come in all shapes and sizes. With some experience, you will become used to judging your approach angle to the runway, based largely on how the runway appears in the window. However, there are many factors that can cause some visual illusions, making it difficult to assess your approach.

A long runway can make you look high, whereas a wide runway can make you appear low. Terrain, runway slope and other features cause these kind of confusions, which is a known problem for pilots.

To make your approaches easier, approach path guidance lights have been developed, which use a colour coded set of lights to easily guide you down the approach. The most common of these is the Precision approach path indicator, or PAPI.

PAPIs normally have 4 lights, set out in a row side by side. The lights are colour coded in the following way:

White	White	White	White	All White	Too High
White	White	White	Red	3 White	Slightly High
White	White	Red	Red	2 Red & 2 White	Correct
White	Red	Red	Red	3 Red	Slightly Low
Red	Red	Red	Red	4 Red	Too Low

You want to keep 2 reds and 2 whites, all the way down the approach. If you see 3 reds, for example, you are slightly low and need to reduce your rate of descent. PAPIs lose their accuracy just before touchdown, so once reaching roughly 100ft, shift your focus to the aiming point markings on the runway, which we will look at next.

VASIS

Another variation on approach path indicators are Visual Approach Slope Indicator Systems (VASIS). They follow a similar red/white logic as a PAPI, but are configured differently.

VASI systems are arranged into two or three bars of lights. When two bars are installed, you are looking for one bar to be white and the other red, indicating you are on the correct glidepath.

All white or all red have the same too high/too low logic as a PAPI.

When three bars are used, you only use two of the three. Which of the three bars you ignore depends on your aircraft type. Most aircraft will use the lower two bars, disregarding the top bar of lights. If flying a wide body, long haul airliner, the top two bars are utilised, and the bottom bar is disregarded. This would apply if flying a 747, 757, 767, 777, A380 etc.

RUNWAY MARKINGS

Runways have a system of painted markings, which are mostly standardised internationally, for making the runway easy to see and use. Not all runways have a full set of markings, as smaller airfields don't require them, but large airports will typically have a fully lit and marked runway.

The centreline of most runways is marked, making it easier to stay central when taking off and landing, especially in the case of a crosswind, or an engine failure in a multi engine aircraft.

To help you touch down in the correct spot on the runway, there is an aiming point marked out, within a touchdown zone. The zone will be marked by repeating double lines. You should not touchdown and further down the runway than the last of these lines. If it looks like you won't land within the touchdown zone, you should go-around, as otherwise you might not have enough runway to stop. The aiming point is the centre of the touchdown zone and is marked with large, wide markings.

For landing, the aiming point should be kept in a constant position in the cockpit, and is literally aimed at until you start the landing flare.

Runways will have numbers, defined by their magnetic direction. For example, a runway that points directly West, which is 270 degrees, will be numbered runway 27. If an airport has parallel runways, they will also be designated with Left and Right.

The stripes at the ends of the runway, commonly called the piano keys, make the runway ends easier to see and also are an indication of the runway width. A standard 45m wide runway will have 12 piano keys, whereas a 60m wide runway would have 16.

Typically, the whole runway length can be used for taking off, although Depending on what terrain and obstacles are on the approach to a runway, the full length may not be usable for landing. This unused length is called a displaced threshold and is shown by arrows. You can begin your takeoff here, but you must not touch down within this threshold. If the threshold has yellow chevrons, they are not to be used takeoff or landing and are simply there as extra runway for emergencies.

If a runway has a large painted "X", it is closed and must not be used.

RUNWAY LIGHTING

Runways are of course used night and day, so a system of lighting is usually put in place. The green bar shows the beginning of the runway, the red shows the end. As you near the end of the runway, the centreline lights will become alternating white and red, showing 900m remain. Towards the very end, the centreline turns all red as you reach the last 300m.

The painted aiming point can't be seen at night, so this too has a lighting system on large runways. Many rows of light bars stretch from the runway start until up to 900m down the runway. This indicates the touchdown zone, as we discussed earlier, with the aiming point in the middle.

Only the largest runways have the full system of lighting and marking, and there are many variations, but now you know the basics and can apply this knowledge when needed.

TAXIWAY MARKINGS

Large airports can be a maze of taxiways and aprons. Finding your way can be easier said than done. A system of taxiway lights and markings has been developed to help guide you.

The most basic taxiway marking is its centreline. Painted yellow to differentiate itself from runway markings, a taxiway is marked by its centreline. By keeping the aircraft on the centreline, you can be sure that you will be clear of buildings and obstacles and that the surface is strong enough to support your aircraft.

At night, major taxiways have a centreline lit with green lights, with the edges often lit blue. Taxiways are named by letters of the alphabet. They are intended to follow a logical pattern, such as Taxiway A (Alpha) being the first taxiway onto a runway, followed by B (Bravo) and so on. However, at older airfields this pattern can be disrupted, as years of re-organising and building of new aprons and terminals begin to increase the complexity of the taxiway system. Careful navigation is needed to avoid wrong turns, which at a busy international airport can quickly cause massive disruption.

You can easily determine which taxiway you are on by the signage. A black sign with yellow letters tell you which taxiway you are on right now. Remember: Black Square, You're There.

The opposite of this, a Yellow sign with black lettering, show upcoming taxiways. An arrow is often included at busy intersections to aid orientation.

Many taxiways will have restrictions, such as a maximum wingspan. A wingspan restriction allows you to be confident that while using that taxiway your wings will not strike other aircraft or hazards. Such restrictions will be written in the airport charts for that airfield, with the most significant restrictions often painted on the ground itself.

To help indicate when you are entering a runway and to assist ATC with sequencing the flow of traffic, many taxiways have holding points. These take two forms:

Type A

These holding points are important to spot, as they indicate the last holding point before entering a runway. These should never be crossed without clearance from ATC. Type A holds are directional and can be crossed freely from one direction but must not be crossed without clearance from the other direction. These are usually arranged so that you must await clearance before entering a runway, but you may cross them freely when vacating a runway, to help keep the runway clear.

Type B

These are intermediate holding points and can be used by ATC to help sequence aircraft into the optimal order for takeoff. These holding positions can be crossed unless told otherwise and can be crossed in either direction.

Holding positions are named to match the taxiway on which they are located. For example, taxiway A may have holding positions named A1 or A2.

At airports with the capability for Low Visibility Procedures (LVPs) there will usually be a red stop bar that spans across the holding point, acting in the same way as a red traffic light on the road. Even with ATC clearance, a red stop bar must not be crossed until it is switched off to indicate you may proceed.

An airport can appear as a confusing web of aprons, taxiways, holding points and runways, but there is method in the madness. These markings and lighting are standardised across the globe, with only occasional variations. For example, some runways in Scandinavia have yellow markings, to make them more easily visible in snowy conditions, which occur regularly. Many runways in the UK have a slightly different touchdown zone marking, again to aid visibility, helping it to stand out on a heavily used runway with thick rubber deposits.

APPROACH LIGHTING

As with runways and taxiways, providing lighting to the approach path will greatly improve visibility and allow far easier visual guidance towards a safe and accurate landing.

Often influenced by the local terrain and landing capabilities available, approach lights take many forms. although they are largely standardised, a great variation of lighting patterns can be found worldwide. Approach lighting is there to help you visually acquire the runway and its surroundings. This is most apparent at night, where they provide great assistance with judging distance to go, approach slope and even offers an equivalent horizon to aid keeping wings level. In addition to night lighting, approach lights come into their own in low visibility, where thick fog can mean the runway would otherwise not be sighted until just a second or two before touchdown. This would not give enough time for the captain to successfully verify that the approach has correctly led the aircraft to the landing zone.

To give the pilot much more time, approach lights stretch out from the runway and will be the very first indication that the pilot can receive to judge the progress of their approach. Having this increased safety margin allows for landings in thicker fog than would otherwise be possible.

ALTIMETRY

Indicated Altitude & QNH

The air pressure is reported in a METAR as it gives indications of many factors. Knowing the local air pressure at your departure and destination is important, as it is used to define your altitude above sea level. To explain this, we will briefly discuss how an altimeter functions.

An altimeter works much like a pressure gauge that indicates in reverse. It contains a sealed chamber, which maintains a constant pressure. As an aircraft climbs, the air pressure outside reduces, causing the chamber to expand. The higher you fly, the lower the air pressure and the more the chamber expands. The exact expansion of the sealed chamber is precisely calibrated, allowing the expansion to drive a needle, accurately indicating aircraft altitude.

There is an important distinction to be made between height and altitude. Height is the distance above the ground below, whereas altitude is the distance above the worldwide average (mean) sea level, MSL.

It would be difficult to use height above ground level (AGL) as a reference for aircraft, as the elevation of the terrain below changes massively from place to place. To fly a constant height above ever-changing terrain would mean continually climbing and diving to keep the ground at a fixed distance as you traverse valleys and mountain ranges, which is clearly not ideal. Using an airfield elevation as your reference is not much use either, as airports can be located at very different elevations. Anything from sea level (or even slightly below MSL in the case of Amsterdam) to thousands of feet up a mountain range is possible. Also, another aircraft would be using another airfield as their reference, giving very inconsistent results.

The mean sea level is a good reference for aircraft as it provides a reliable and consistent datum around the world. Therefore all aircraft can use MSL as their altitude reference, allowing far greater consistency and safety.

So, while the sea level remains constant, what does change from day to day is the air pressure. As an altimeter is a pressure gauge that indicates in reverse, if the pressure drops overnight, the altimeter would show an increase in altitude, even while the aeroplane is parked in the hangar. To compensate for these changes, the local air pressure is reported on METARs, in units of hectopascals (hPa) or inches of mercury (in Hg) and is known as the QNH.

The QNH is dialled into the altimeter before takeoff or landing and will correct for any localised variations in pressure. Each 1hPa of pressure equates to around 30ft. When QNH is set correctly, the altimeter will display altitude Above Mean Sea Level (AMSL). This means that when on the ground, rather than indicating zero feet, the altimeter will display the aerodrome elevation. If you wind the setting so that zero feet is displayed, you are now indicating your height Above Airfield Level (AAL). The pressure setting required to indicate zero is known as the QFE, but this is rarely used and generally not included in weather reports.

In the USA, the convention is to use units of Inches of Mercury, which is reported as A2992 to represent 29.92 inches, the standard setting and is equivalent to the standard QNH of 1013 hPa. Most altimeters allow use of either unit.

Radio Altimeter

When closer to the ground, most larger aircraft have a separate method for measuring the current height over the ground (AGL). This is done with the use of a Radio Altimeter or RADALT. This system sends a radio beam directly downwards from the aircraft and measures how long it takes to be reflected back. As the radio beam travels at the constant speed of light, by measuring the round-trip time the RADALT computer can very accurately determine the aircraft's height over the ground at that moment.

Only effective at relatively short ranges, a RADALT can provide a very clear and accurate height up to roughly 2500ft, where most systems will automatically remove the needle or display from view.

These systems are most effective for the late stages of landing, where completing a landing in marginal weather requires the most exacting figures available.

Flight Levels

We have discussed altitudes based on height above ground (AGL) and height above sea level (AMSL). Using these as a reference for measuring altitude works very well at lower levels and for short range flights. Problems can begin to appear however when longer distance travel is desired. If using the local QNH to give Altitude AMSL, your altimeter will only read correctly if you stay nearby to the airport the QNH is based on or if you continually obtain and set each local QNH as you pass by. This would be quite tedious, time consuming and open to error.
A factor to also account for is that other aircraft flying from other places will have other QNH settings dialled in. We can see a mess beginning to emerge, especially in today's busy skies.
A solution is needed and it comes in the form of Flight Levels.
A Flight Level is an altitude based on an internationally standardised QNH of 1013. It is agreed that all aircraft flying at or above a certain altitude will use Flight Levels as this ensures that all aircraft enroute throughout the globe are all using the same QNH setting of 1013, thereby ensuring safe clearance between aeroplanes.

The altitude at which you transition to using Flight Levels is called the Transition Altitude (TA) and this varies from airport to airport, depending on local airspace and topography.
The minimum available Flight Level is called the Transition Level (TL). The gap between these two is referred to as the Transition Layer.

To clearly distinguish between an Altitude and a Flight Level, there is a difference in terminology and presentation. A Flight Level is presented with a preceding “FL” and three figures for that altitude in hundreds.

For example; 15,000ft is equivalent to FL150.
To set a Flight Level, you simply set the QNH on your altimeter to 1013. Some aircraft have an ability to easily toggle between the local QNH and 1013 which is often labelled “Standard” or “STD”.

ALTERNATE AIRPORTS

At the planning stage, most commercial flights require a plan B. It makes perfect sense, issues will appear from time to time that require at an airport other than your planned destination. Some potential causes:

- Thunderstorm overhead destination
- Low Visibility
- Damage to runways
- Emergency traffic blocking runway
- Excessive traffic
- System failures requiring longer landing distance

Any of these eventualities can come your way at any time, so they are included in routine flight planning and are only occasionally omitted.

To plan a flight without an alternate airport, certain requirements must be met, and are usually only permitted if you are compelled to do so, in cases such as needing to reduce fuel loads due to limiting takeoff performance. To depart without an alternate, you must ensure the following conditions are met at the destination airport:

- Flight time <6hrs
- At least 2 separate*, available runways
- Cloud base 2000ft
- Visibility 5km
- Weather not forecast to worsen between ETA +/-1HR

*To be considered as separate, the runways must be separate landing surfaces that may cross each other, but only in a way that means if one becomes blocked it will not also block the other. The approach to each runway must be separate and based on a separate navigation aid.

Some airports are so remote that no viable alternate exists within a reasonable distance. Generally, if the alternate fuel + final reserve t is over 1.5 hours away, the destination is considered “isolated” and no alternate is required. In such cases, other criteria must be considered

In some cases, two destination alternates may be mandated. This would be in the situation where the weather forecast for the destination indicates conditions that would preclude a landing, such as visibility below the minimum required for that approach. Two alternates would also be selected if no weather forecast was available before departure.

Takeoff Alternates are used if following a problem after takeoff, a return to the departure airfield is not possible due to performance requirements or weather conditions. A typical case where this might occur is in foggy conditions, where the visibility may be enough to takeoff but not insufficient to make an approach. An airfield within an hour’s flying time (disregarding wind) will be nominated as a takeoff alternate to provide a safe escape.

ICAO ANNEXES

There are countless documents, manuals, regulations and so on that span all aspects of aviation. Most are based upon the foundations that have been developed by The International Civil Aviation Organisation, ICAO.
ICAO was formed in 1944 with what is called the Chicago Convention. This gave ICAO the status as the international authority for civil aviation.

The Chicago convention has a set of 18 annexes, each of which deals with a different aspect of aviation. We'll quickly run through the annexes mostly to show you where to look to find more information.

Personnel Licensing

Annex 1

The first outlines all the requirements for the many licences that are held by anyone working in aviation. The license you hold will depend of what type of flying you are involved in. You could fly an aircraft on the weekends with a Private Pilot's License, a PPL, although a main restriction of this is that you may not be paid to fly. To fly as a job, meaning commercially, you need a CPL, a commercial pilot's license. To this you may need to add additional qualifications, such as an Instrument Rating or Multi Engine rating. You would need all of the above plus the completion of written examinations to form an ATPL, the airline transport pilots license. The restrictions and requirements of each of these various qualifications are all detailed in Annex 1.

Rules of The Air

Annex 2

To drive a car, you need to follow the highway code of the country you are in. It is much the same with aviation. ICAO annex 2 covers the highway code of the skies that apply for all countries. We'll look quickly at some of the basics.

Right of way. Aircraft can take many forms, anything from a super agile fighter jet to a hot air balloon. Therefore, we have a wide spectrum of agility, which form the basis of the right of way system. For example, a fighter has much higher manoeuvrability than a glider, so the fighter is expected to give way. Annex 2 outlines who has priority. Roughly speaking, as the captain of an airliner, light aircraft or other power aircraft, you need to give way to Balloons, Gliders, Airships and Aircraft which are towing another aircraft or objects such as banners.

If two aircraft are converging, the aircraft that sees the other on it's RIGHT side, shall give way, except in the cases of airships etc, mentioned above.

If two aircraft are converging head on, they will BOTH turn to the RIGHT.

If a fast aircraft needs to overtake a slower one, the aircraft being overtaken has priority and is expected to maintain its heading and speed, while the overtaking aircraft will pass on the right.

Annex 2 also covers general rules of the air regarding towing, dropping objects and formation flights.

Meteorology

Annex 3

Annex 3 is focused more towards the standards that ATC have to meet when providing weather information. As the captain, you will base your decisions on the information available to you, so it is important that the weather is reported reliably and accurately, so that you can make a well-informed decision. Especially when fog is present at an airport, up to the minute reports on visibility will be closely watched by pilots. It is important that the information is presented in the right format, and that pilots know how to correctly decipher the information they are provided with.

Charts

Annex 4

Each airport has its own set of approaches, departures and procedures. Pilots have charts that display all of this information. The guidance for producing these charts is provided by Annex 4.

Units of Measurement

Annex 5

Almost all countries use the standard ICAO units of measurement, as listed in annex 5. This uses Feet for Altitude, Centigrade for temperature and hPa for pressure. Although some countries have differences, such as the USA using inches of mercury for pressure, or Russia sometimes using meters for altitude.

Operation of Aircraft

Annex 6

This is one of the more relevant annexes to flight crew. Annex 6 covers how a flight should be prepared, with regards to weather requirements, minimum fuel levels, what documents need to be carried on board and what equipment needs to be fitted to particular types of aircraft.

Nationality and Markings

Annex 7

Each aircraft has a registration number, which needs to be displayed. Each country has it's own registration letter, such as G for Great Britain or F for France. Annex 7 sets out the requirements for this.

Airworthiness

Annex 8

Aircraft are designed to be as safe as possible. There are many regulations that have to be satisfied before an aircraft can be deemed airworthy. Annex 8 sets out these requirements, which are of more relevance to the subject of aircraft design.

Facilitation

Annex 9

Civil aviation is all about transporting people. It wouldn't be any good if all other regulations have been met, only for the passengers to be unable to take their flight because the airport doesn't have the right facilities. These can be things from baggage and cargo processing, security and parking for aircraft. These are all detailed in Annex 9.

Telecommunications

Annex 10

Aircraft rely on radio beacons such as VORs, NDBs and others. These facilities have a set of regulations that are written in Annex 10 and need to be adhered to, in order to be used for aviation. They include regulations such as maximum ranges that the navaid can be reliably used. Standardised use of numbers and letters are also covered, including the phonetic alphabet.

Air Traffic Services

Annex 11

Air Traffic Control is a subject in itself but the basic structure can be found in Annex 11. Here we find information regarding the various levels of service that Air Traffic are required to provide to pilots. This could be anything from information about other traffic in their airspace to the serviceability of navigation aids.

Search and Rescue

Annex 12

Should the worst happen, the services of search and rescue may be required. There are some signals that a pilot should know, and are listed in Annex 12.

Accident Investigation

Annex 13

Civil aviation is very successful in learning from past mistakes. Investigating an accident is all about preventing it from reoccurring, rather a witch hunt to find 'who's to blame'. An investigation is a highly organised operation and the basic guidelines are given in Annex 13.

Aerodromes

Annex 14

In the same way that an aircraft must be airworthy, an airport must be fit for purpose too. Annex 14 lists the requirements that an airport operator must meet in order to provide a safe airport. These include the standards for firefighting, backup power supplies and taxiway and runway markings.

Aeronautical Information Services

Annex 15

Staying up to date with the latest information is very important for making sensible decisions. If a runway at your destination is closed, you need to know about it before you begin the flight. This information is supplied via Notices to Airmen, NOTAMs, which apply to each airport and must be checked. Annex 15 sets out the format and other requirements for the communication of information to the right people at the right time.

Environmental Protection

Annex 16

Flying often seems to get bad press with regards to noise and pollution. A large aircraft is still the most efficient way of moving such large numbers of people such long distances in such short times, but it still has a responsibility to do this in the most environmentally aware way possible. Annex 16 relates to topics such as aircraft noise requirements, which is closely monitored.

Security

Annex 17

Aviation security is becoming more and more relevant to the travelling public. Annex 17 sets out recommendations for countries with regards to forming their legal framework and methods for dealing with aviation related crime.

Dangerous Goods

Annex 18

Annex 18 covers the subject of Dangerous Goods. This is of interest to pilots as some items can post a danger to aircraft, but be perfectly safe elsewhere. An example might be a mercury thermometer. Mercury practically eats the aluminium of an aircraft, so It is important to have systems in place to prevent anything being allowed onboard that can cause damage or injury. Some parts of an aircraft such as safety equipment and fire extinguishers are considered as dangerous goods but are given special treatment as they are considered necessary.

Further information can be found in the dedicated section on Dangerous Goods.

Summary

So now you know where to look for more information on the general international rules for air transport. Absolute knowledge is not the target, but knowing where to look is half the battle and is beneficial.

These are the standard international rules, although each country has the right to have their own local differences. Often these are to do with flight plans and administrative differences, but some countries such as the UK and especially the USA have many significant differences to these basic regulations. They are referred to as differences to ICAO and are listed for each country.

WAKE TURBULENCE

Much like a boat moving through water, a wing producing lift will leave a wake of disturbed air behind it. Small aircraft will only have a small wake, whereas a heavy jet will produce dangerous turbulent conditions called Wake Turbulence.

Categories

To help ensure that a lighter aircraft does not come into harm's way, a system is in place to categorise aeroplanes and allow safe separation between aircraft.

Super	A380	A380
Heavy	136T or more	A330 A340 A350 B747 B767 B777 B787 MD11 DC10
Medium	7T-136T	A320 B737 MD80 CS100 ATR42 B757* Dash8 ERJ145
Light	7T or less	

*The B757 is generally considered to be in the medium wake category, although some countries treat it differently. In the UK, a B757 is considered as “Upper Medium” when landing, meaning a Light or Medium directly behind will be given extra distance. In Italy, the B757 is always considered Heavy.

The Heavy and Super category aircraft are required to announce their wake category on the first contact with each ATC centre the pass through, giving rise to callsigns such as “Speedbird 318 Heavy” or “Emirates 10 Super”.

Separation

The exact distance applied between two aircraft depends on the wake category of each and if we are considering the Takeoff or Landing case.

Leader	Follower	Takeoff	Intersection Dep	Landing
Super	Heavy	2 mins	X	6 nm
Super	Medium	3 mins	4 mins	7 nm
Super	Light	3 mins	4 mins	8 nm
Heavy	Medium	2 mins	3 mins	5 nm
Heavy	Light	2 mins	3 mins	6 nm
Medium	Light	2 mins	3 mins	6 nm

Departures are separated by time in minutes between successive lift-offs, whereas landing separation is applied in nautical miles.
There is no specific separation when following an aircraft in for landing that is in the same wake category as yourself, although the limiting factor is often a radar minimum distance for 3-2.5nm in these cases, depending on what type of ground radar system that airport has in place.

The full runway length is not always needed for takeoff, so an intersection might be used, saving valuable taxi time and fuel. From a wake perspective, this reduced takeoff run would shorten the time between successive departures, so 1min of extra time is added when departing from an intersection behind a heavier category aircraft.

When parallel runways are spaced 760m or less from each other, the two runways are considered as one when determining separation. E.g. If runways 27L and 27R are under 760m apart, a B747 departing 27L would necessitate wake separation for a subsequent B737 departing 27R.

No separation is needed for a landing aircraft behind a departure, as their flight paths will not meet so no wake will be encountered. Wake separation is primarily an ATC responsibility, but the Captain must be satisfied that the appropriate spacings are being provided.

METAR REPORTS

Rain or shine, a pilot needs to know the weather of the departure airfield, enroute and at the destination. The exact details of temperature, cloud base, wind speeds etc need to be communicated quickly and clearly in a standardised way. This is done by the use of METARs and TAFs.

The definition of METAR varies slightly between countries, but is generally referring to a Meteorological aerodrome report. A METAR provides a snapshot of the current weather at an airport and is published at regular intervals, generally hourly. They are generated either manually or automatically, depending on the equipment in use at a particular airfield. Automatically compiled METARs begin with “AUTO”.

It is within a METAR that the detailed weather information can be found. Information contained within the message can include:

- Airport
- Date and Time
- Wind direction and speed
- Visibility
- Temperature and dew point
- Cloud type and height
- Precipitation type and intensity
- Air pressure
- Trend of weather changes

That is a lot of information to communicate. Looking at an example METAR will show us how we get so many details into a short message.

EGCC 300520Z AUTO 19004KT 150V230 9999 FEW040CB -SHRA 12/11 Q1001 NOSIG

To understand what information we are seeing, we can break this message down into its components, which we'll run through one by one.

Airport Code

EGCC
ICAO airport code for Manchester, UK.

IATA Codes

Each airport has its name converted into two types of code. IATA and ICAO. IATA is a 3-letter code that many frequent fliers will already be accustomed to.

Here are some well-known examples:

LAX	Los Angles
LHR	London Heathrow
JFK	New York John F. Kennedy
SFO	San Francisco

ICAO Codes

Less familiar to the travelling public, ICAO codes are the type used almost exclusively by pilots and ATC.
As a 4-letter code, it contains information about the airport location. The first 1-2 letters help to locate the airfield. Conventions vary by location, but in Europe the airports are divided by upper (E) and lower (L) areas within Europe, followed by the country. The remainder of the code defines the individual airport, occasionally using letters from the airport name, but usually are simply allocated.

A few examples will show the most common conventions:

LFPG	Lower Europe, France, Paris Charles de Gaulle
EGPH	Upper Europe, Great Britain, Edinburgh.
NZHN	New Zealand, Hamilton
EHAM	Upper Europe, Holland (The Netherlands), Amsterdam.

Date & Time

300520Z
Day of the month (30) and the time in UTC (0520Z).

A METAR is published typically every hour or half hour, giving regular updates to provide a snapshot of the current weather conditions.

UTC Time
As the earth is a rotating sphere, local time of day at the same instant varies around the globe. To manage this, the earth is generally divided into 25 time zones, named A-Z (Skipping J). Each zone represents an hour difference from UTC (Universal Coordinated Time).

For example, GMT +1 is time zone A, GMT +2 is B, etc. GMT itself is time zone Z or “Zulu” in the phonetic alphabet, giving rise to the convention of Zulu Time or UTC.

J was not used to avoid confusion with letter I, as this was the convention around the 1800s when this system was devised. Occasionally J is used to represent the observer’s own local time, but this is almost always represented as L for Local.

Previously referred to as Greenwich Mean Time (GMT), Universal Co-ordinated Time (UTC) is used throughout the world to avoid confusion and is in regular use in aviation.

Observation Type

AUTO
AUTO indicates that this METAR has been compiled automatically by software, as opposed to by a human observer.

Wind Direction & Speed

19004KT

This represents the average (mean) wind direction in degrees true (190) and wind speed in knots (04).

Wind direction is rounded to the nearest 10 degrees and indicates to the pilot which direction the wind is coming from. In our case, it is blowing from 190 degrees, which is roughly from the south.

As runways are numbered in degrees magnetic, while METARs give wind in degrees true, care should be taken when working out if you are to expect a headwind or tailwind, or if the crosswind is within your aircraft’s limits.

Some airports can be highly disrupted by even moderate winds if they are coming from an inconvenient direction. For example, if an airfield only allows landings in one direction, possibly due to terrain, a tailwind can easily prevent landing. As the commander, you would need to be very aware of this possibility, as it may increase the chance of a diversion dramatically, which needs careful planning.

In other cases, terrain or buildings may cause turbulence when landing, if the wind has to pass by those obstacles before reaching the runway. An example of this could be the hangars just to the south of London Gatwick 26L, where a relatively moderate wind speed, as little as 10-15 knots, can cause considerable turbulence and rolling to an airliner just moments before touchdown. Look upwind to see if any obstacles are near the runway, as this can help you predict these disturbances.

Wind speed in aviation is almost always measured in knots (KTS) meaning nautical miles per hour. Some reports may use Meters per Seconds (MPS), which can be roughly converted into Knots by doubling the figure.
For example, 10 MPS = Approx. 20 KTS.

Degrees True vs Magnetic

To understand what is meant by degrees True, we need to take a quick look at how positions on the earth are described. A location can be described by coordinates, which give a position on the globe as a Latitude and Longitude. Lines of longitude run north south between the poles. This ‘Geographic’ North pole is different to the Magnetic North pole, which moves from year to year and is where a magnetic compass would lead you to. given in degrees true, meaning degrees from a North which is aligned with the earth's lines of Longitude. The difference between True North and Magnetic North is known as Magnetic Variation. This variation changes from year to year and place to place and can be quite considerable. In the UK, variation is as little as about 2 degrees, whereas in New Zealand it can be as high as 20 degrees.

150V230

Wind direction and speed are not always smooth and constant. Wind direction can vary minute by minute and strong gusts can come and go by the second. This presents increased difficulty in aircraft handling and so are reported. To show that the direction is variable, a V or VRB is used. A V is surrounded by the extremes in direction. So 150V230, as in our example, represents a variable wind between directions of 150 and 230 degrees true.

Often very light winds are described as VRB as they are not strong enough to determine their direction. Speed is reported as an average over a short period, usually the last few minutes.

Gusty conditions can make handling more difficult, as your airspeed, vertical speed and sideways drift can all vary second by second. To indicate the presence and severity of gusts, G can be included in the wind speed.
For example, if the wind was from the south at 15 knots gusting up to 25 knots it could be represented as 18015G25.

Visibility

9999

These numbers represent the visibility from the airport in metres. A figure of 5000 would represent 5km visibility. In clear conditions, of visibility of over 10km, the numbers 9999 are used, sometimes referred to by pilots as “all the nines”.

With relatively good visibility, distances can be estimated by an observer, such as reporting the distance to the furthest visible object.

Visibility can be reduced by many factors, such as rain, mist or smoke. When the visibility is reduced, the cause is often included. For example, if visibility is 5km on a hazy day, this might be reported as 5000 HZ.

Visibility can occasionally be very different in one particular direction. This is reported in the METAR as the visibility in metres followed by the direction, such as “3500NW” representing 3500m to the North West.

Here are some of the causes of reduced visibility, their associated METAR code and what the implications can be.

Mist **BR**

Visibility below 5km. Visibility somewhat reduced. Usually unable to depart for a VFR flight as 5km visibility is usually required for VFR. IFR flights generally unaffected.

Fog **FG**

Visibility Below 1000m. Greatly impaired visibility. Extra caution and reduced speeds when taxiing. Traffic flow restricted, causing holding and delays. Tends to form or worsen in the early hours, as the rising sun causes heating and mixing. Often dissipates to reveal a clear day, but can linger for many hours, not helped by the characteristically low wind speeds that accompany fog.

Smoke FU

From the French "Fumer", smoke can cause localised reductions in visibility. Ingested smoke can enter the aircraft cabin via vents or air conditioning, potentially causing alarm amongst passengers or triggering smoke warnings from the aircraft systems. Thick smoke is usually highly visible and avoidable in the daytime, but can be unexpected and invisible at night. Blows downwind and can change direction repeatedly. Usually very localised and of short duration.

Volcanic Ash VA

A very serious threat. Ash will clog ports and engine intakes, while causing serious abrasion on the paint and windscreens. A jet aircraft can experience loss of thrust or failure of all engines.

Abrasion and clogging are likely to persist, but a jet engine can recover. The ash comes into contact with the red-hot turbine blades at the rear of the engine, effectively being heated and turned into a glass-like material. These deposits can significantly affect airflow and ruin engine performance. Once cooled, this material has been known to break away and clear, so attempts to restart should continue for as long as possible.

Ash deposits can also fall to the ground and fill the runways and taxiways, closing an airport and taking many hours or days to clear.

Sand SA

Masses of airborne sand can cause very severe reductions in visibility and will easily close an airport. In a similar manner to VA, Sand can clog vents, intakes and ports. Use reduced engine power when taxiing and be considerate as to where your thrust will blow the sand.

While the visibility is reduced due to some phenomena such as Smoke or Fog, there is often good reason to include a little extra data to describe how it is distributed at the airfield. Here are some of the codes you may come across:

Partial	PR
Patches	BC
Shallow	MI
Drifting	DR
Blowing	BL

Cloud

FEW040CB

The density, height and type of cloud is an important factor when considering airfield weather. Density is conventionally described in units called Octas, which generally represent how much of the sky is obscured. Obscuration is rated as a number out of 8 Octas, described in a METAR with the following system:

1-2	Few	**FEW**
3-4	Scattered	**SCT**
5-7	Broken	**BKN**
8	Overcast	**OVC**

The height of the cloud bottoms is given in hundreds of feet above the airport elevation. Our example gives 040, meaning a height of 4000ft. The height of the cloud is measured as height above the airfield, as opposed to altitude. So if an airport has an elevation above sea level of 500ft, a reported BKN020 will be encountered at 2500ft indicated altitude.

NCD If the skies appear to be clear to an automatic observing system, NCD (No Cloud Detected) may be included in an AUTO METAR.

Some scattered clouds at 3000ft are unlikely to cause much distress. Conversely, a storm cloud can cause great challenges. Significant cloud is reported as such using the following coding.

Towering Cumulus TCU

A cumulous cloud with great vertical development. Strong air currents are contained within but tend to affect only at very short range. Can be avoided at close distances. Less severe than a CB, but still attempt to avoid. Can cause delays if found on the approach path.

CumulonimbusCB

A more developed cloud, posing a serious threat to anyone straying too close. A CB contains far harsher conditions than a TCU, and are usually far larger. Air currents are fierce and further reaching, so a wider margin is needed for avoidance. If approaching an airfield with a CB nearby, proceed with great caution and be prepared for windshear.

CAVOK

Stands for Cloud and Visibility OK. This does not necessarily mean clear skies, as it is used if the following conditions are met:

- Visibility 10km or more
- No cloud below 5000ft or the MSA
- No CB or TCU at any height
- No precipitation

Precipitation

-SHRA

Next in our METAR code we'll find any significant conditions, such as precipitation. Its type, frequency and intensity are all coded with a simple system.

Many variations of precipitation can be found all around the world. From hail stones to drizzle, a code is in place to identify the prevailing conditions.

When it comes to rain, everyday experience reminds us that it can take various forms. A shower (SH) means the rain passes quickly, usually followed by more shortly after. Drizzle (DZ) on the other hand can linger for what seems like hours or even days.

The frequency is implied by the type of precipitation. Rain (RA) may be long lasting but Rain Showers (SHRA) may be short lived.

The intensity is assumed to be moderate unless accompanied by - (Light) or + (Heavy). Heavy precipitation of any kind will be worth your attention.

Here is a selection of some of the most common forms that precipitation and weather conditions can take and what it means to you as a pilot.

Showers SH

Can be heavy, but temporary. Usually more showers are coming but are small and seen easily, making them easier to avoid. Look upwind to see what is coming.

Drizzle DZ

Rarely heavy, fine rain droplets reduce visibility and is unlikely to cease in the immediate future. Can thoroughly drench grass runways and painted markings, making them very slippery. Usually widespread.

Hail GR

Hail stones can cause significant damage, as passing through them at speed can severely harm propellers, nose cones and windscreens. Often of short duration and located nearby or within Cumulonimbus (CB) Cloud. To be avoided when at all possible.

Freezing Rain FZRA

Rain that freezes to your aircraft on contact, building up rapidly and dangerously. Can clog intakes, disrupt wing airflow and increase aircraft weight at dramatic speed. A rare but severe occurrence.

Heavy Rain +RA

Larger rain droplets in vast quantities. Causes such a great reduction in visibility that windshield wipers are of little help. Runway may be unable to drain water quicker than it falls so standing water or flooding can appear rapidly. Water ingested into engine may reduce performance or cause failure in extreme cases. Aircraft may lose momentum against the wall of water and have reduced thrust. Usually isolated.

Snow SN

Usually light but in continued cold conditions will build up and has potential for huge disruption. Can take hours to clear runways and taxiways, especially if not forecast.

Slippery on the ground, taxi with care. Can be widespread, with alternate airports filling up with diversions quickly.
Cleared snow will be formed into banks near the taxiway, ensure your wings or engines will clear them. A runway does not always need to be cleared completely, so the visible tarmac may be misleading as to the runways real proportions, causing confusing visual illusions when landing.

If a period of significant weather has ended, but is still worth mentioning, a Recent (RE) code can be incorporated. You may come across codes such as RETS or RERA, indicating that these weather phenomena have ceased, but may have lasting after-effects such as disruption or water patches.

Air Temperature

12/10

The air temperature and dew point are presented together, to give the outside temperature and humidity. Measured in Centigrade, the temperature can have profound effects on the aircraft performance and operation. On hot days with strong sunshine, dark surfaces such as roads and car parks will heat up quickly and will conduct much of that heat into the air directly above, causing an updraft of warm rising air. These narrow columns are called thermals and can be quite destabilising on the approach and landing.

When entering the thermal, the aircraft be carried upwards with the rising air, putting you slightly high and suggesting reduced thrust to descend. Shortly after, when leaving the thermal, you will begin to fall back down as you lose your updraft. As you may have reduced power to regain the glidepath, you will find yourself pulling the nose up to arrest your sink rate and require a boost of thrust to maintain speed. This process may repeat itself several times on a single approach and makes a stable approach more difficult to achieve.

The first figure is the temperature, followed by the dew point. The dew point is a useful figure to consider, as it represents the temperature at which the air will reach 100% humidity. When such a condition exists, the air cannot carry any extra moisture, causing mist or fog.

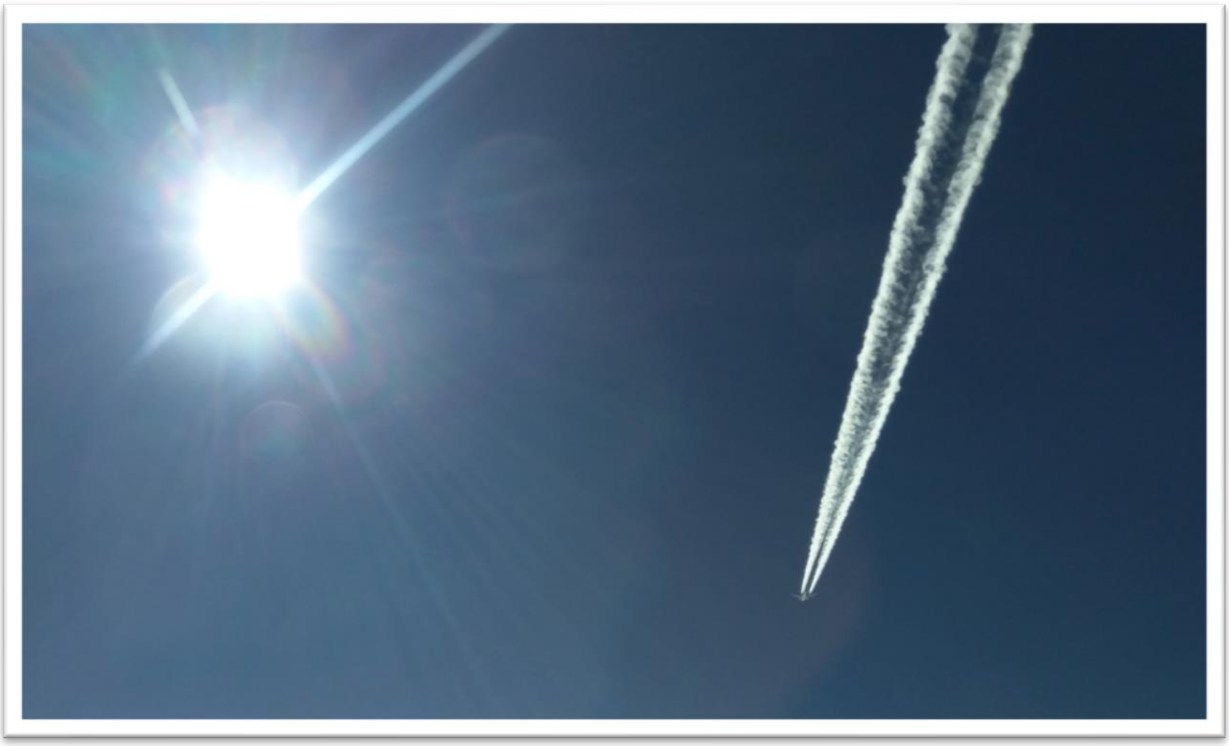
On hot days, aircraft tend to have decreased performance, as the warm air is less dense, reducing engine power output. This also occurs in humid conditions, which can be deciphered in a METAR message as the relationship between the temperature and dew point. For instance, if 10/10 is reported, the air is fully saturated, indicating high humidity, the possibility of fog and reduced performance.

Air Pressure

Q1020

The local reported QNH is listed with 4 digits and a leading Q. An Altimeter setting, as used in the USA, has a leading A. EG A2992 signifies 29.92 InHg.

Refer to the section on Altimetry for more information about QNH and altimeters.



Trend

NOSIG

If No Significant change in weather for the next 2 hours is forecast, the code NOSIG may be included at the end of the METAR. If there are changes on the way, there are the following codes to indicate this to the pilot.

Becoming BECMG

This code is used for a relatively long-term trend in the weather, generally lasting no more than 2 hours, but can on occasion apply up to 4 hours.

Temporary TEMPO

For a more fleeting change, TEMPO is used, indicating a short-term variation in the prevailing conditions, but only for short periods of up to 1 hour.

When more detail is known about the weather in question, more information can be included, such as the times from (FM) or time until (TL) the change will be commencing and ceasing.

TAF REPORTS

A METAR message shows a current snapshot of the conditions at an airfield. But this only reveals part of the story. A forecast is needed to build a more complete picture. In aviation, this is achieved through Terminal Aerodrome Forecasts, known as TAFs.

The coding is very similar to a METAR, but offers a little less detail in exchange for a far wider time range. Here is an example:

TAF LFRB 261100Z
2612/2712 20004KT 9999 SCT030 TX25/2615Z TN14/2706Z
PROB30
TEMPO 2703/2708 0600 FG

We can already find many of the coding conventions already discussed, but we see a slightly different layout for a TAF. We'll decode this TAF and discover the useful information contained within.

Airport Code *LFRB*
A forecast is identified as such by beginning with TAF and the aerodrome to which it applies. In this case, Brest in Northern France (LFRB).

Date & Time *261100Z*
Our example was published on the 26th day of the month at 1100Z.

A forecast is published at intervals which are determined in accordance with its validity period. A TAF that forecasts a period between of 12 hours or less (to a minimum of 6 hours) will be published every 3 hours. Whereas a TAF with a longer validity period, up to 30 hours, will be published every 6 hours.

Weather *20004KT 9999 SCT030*
As with our METAR, we can decode this as a wind of 200/4, visibility of 10KM or more and Scattered clouds at 3000ft AAL.

Forecast Period

2612/2712

A forecast is designed to cover a specified period of time. This XXXX/XXXX format includes the beginning (26th Day at 1200Z) and the end of this period (27th Day at 1200Z), separated by a "/".

Temperature Range

TX25/2615Z TN14/2706Z

A system unique to a TAF message is the maximum and minimum temperatures for a period.

Here we see that the highest temperature (TX) of 25C will be reached at 1500Z on the 26th, followed by the lowest temperature (TN) of 14C the following day at 0600Z.

This can be a useful early indication of temperature extremes in summer and winter, where very high or very low temperatures require special handling and care.

Probability

PROB30

Accurately forecasting the weather for a particular location can be a massive undertaking. With the use of highly sophisticated weather theories and running computer algorithms, we can obtain a very good indication of the likely conditions to come. However, in the real world, things don't always go as expected. There is still an element of guesswork and estimation, with even a tiny misforecast in wind speed, temperature or any number of variables giving rise to a very different result. To help cope with such circumstances, a PROB code can be used to indicate the Probability that a particular set of conditions will occur.

Usually published as either PROB30 or PROB40, this code gives an indication of the probability percentage for a particular condition. In our Brest TAF we see that there is a 30% chance of the following TEMPO condition occurring.

Temporary Conditions

TEMPO 2703/2708 0600 FG

Rated as a 30% chance by the preceding PROB30, This TEMPO indicates that for a time of less than an hour the visibility is forecast to be 600m in Fog.

Weather Report Examples

KJFK 161751Z 33009KT 10SM FEW050 26/06 A3025
New York JFK, 26th day at 1751Z, Wind 330/9 knots, 10 Statute Miles visibility (USA often uses Miles rather than KM) Few clouds at 5000ft, temperature 26C dew point 6C, indicating low humidity. Altimeter setting 30.25 in Hg.

NZSP 030912Z 12010KT 4800 IC BR FEW120 M70/ A2767
The South Pole, 3rd day at 0912Z. Wind 120/10 knots, visibility 4800m with Ice Crystals and Mist. Few clouds at 12000 feet, temperature Minus 70C, dew point not reported. Altimeter 27.67 in Hg.

GCXO 021800 30009KT 4500 2000NW PRFG FEW000 SCT007 19/18 Q1018 NOSIG
Tenerife North, 2nd day at 1800Z. Wind 300/9 knots, visibility 4500m except to the North West where it is only 2000m. Partial Fog. Clouds just over the ground, QNH 1018, not expected to change within the next 2hrs.

KLAX 021513Z 0215/0318 VRB03KT P6SM
SCT030
FM022000 26012KT P6SM SKC
Los Angles, 2nd day at 1513Z.
Between 1500Z on the 2nd and 1800Z on the 3rd, wind light and variable. Visibility 6 statute miles. Cloud scattered 3000ft. From 2000Z on the 2nd, wind 260/12, sky clear.

EGLL 081051Z 0812/0818 27014KT 9999
SCT035 PROB40 TEMPO
0812/0814 28018G28KT 7000 RA
London Heathrow, 8th day published at 1051Z. Between 1200-1800Z, westerly wind at 14kts, visibility 10km or more, scattered cloud. 40% chance of temporary gusts up to 28kts between 1200-1400Z with moderate rain and 7km visibility.

OMDB 021343Z 0213/0218 30012KT
PROB30 0223/0301 1500 BR
PROB30 0301/0305 0150 FG VV///
Dubai, 2nd day, published 1343Z.
30% chance of 1500m in mist, possibly worsening at 0100Z to 150m in fog. Vertical visibility not reported.

HAZARDOUS WEATHER

A Thunderstorm is a vicious package of some of the worst weather conditions. Thunderstorms can take all shapes and sizes, but all will have a dangerous combination of weather phenomena, including:

- Turbulence
- Icing
- Lightning
- Heavy Rain
- Hail
- Strong Wind
- Low Pressure

We'll look at each of these adverse weather conditions and some of the risks they can present.

TURBULENCE

Most flights will encounter at least some air turbulence, as this is a very common occurrence and is completely normal.

However, a thunderstorm can cause very severe levels of turbulence, with strong updrafts within the cloud fighting against the strong downdrafts outside of it. Turbulence is not confined to within the storm cloud, and can reach as much as 20 miles from the storm itself.

Light turbulence is of little interest other than slight discomfort, but severe turbulence can cause injuries to those onboard and can damage the aircraft structure and is something that must be avoided.

ICING

In a storm, water can become what is called 'supercooled'. This is water that is colder than the freezing point, but remains liquid until impact with a surface, such as your aircraft. This can cause serious problems. Severe icing will cause multiple problems. It will disturb the airflow over the wings, increase your weight, reduce engine performance and can interfere with the controls.

Many aircraft have anti-icing or de-icing systems built in, but these are often no match for the severe ice encountered in a thunderstorm.

LIGHTNING

Lightning is one of the most visible hazards of a thunderstorm and can cause damage to aircraft structures and equipment.

A very loud bang will be heard and you may encounter system failures, especially electronic equipment.

After a strike occurs, check your systems straight away to see if anything has been damaged.

The bright flash can cause momentary flash blindness. At night, consider turning up the cockpit lighting, as this will make things easier to see while your eyes readjust after the lightning flash.

HEAVY RAIN

A thunderstorm very often has heavy rain underneath. Such a large amount of water can cause issues for aircraft. The rain will increase the weight of the aircraft slightly, increase your drag and reduce engine power. In a similar way to icing, this can put you into an uncomfortable situation, coupled with a slippery and potentially flooding runway.

Turbofan aircraft can take a lot of water through the intake before they start to choke, as the fan blades centrifuge the water to around and past the engine core. However, a piston aircraft can run into trouble more easily. With enough water, you can experience hydro locking, where the incompressible water is squeezed by the pistons and damages the engine cylinders. Jet powered or not, heavy rain is very hazardous to aircraft.

HAIL

Hailstones tend to fall from under the anvil of a storm cloud. At high airspeeds, these pellets can cause a surprising amount of damage to nose cones and even smashing windscreens or chipping at propellers, racking up expensive repairs. Flying under the anvil of a storm cloud is always to be avoided.

STRONG WINDS

While you can have severe turbulence in and around a thunderstorm, winds can reach very high speeds, causing damage to objects on the ground and raising handling difficulties in the air. A nearby storm could cause the crosswind to exceed the maximum allowed for your aircraft, often requiring a diversion. The wind can change significantly and very rapidly, with strong gusts, headwinds changing to tailwinds and producing unpredictable conditions. With strong winds, buildings and terrain near the runway can cause turbulence low to the ground, so you'll have to stay on your toes.

LOW PRESSURE

Altimeters are basically pressure gauges. As we climb, the air pressure reduces, which the altimeter is calibrated to convert into altitude.

A storm is usually part of a low-pressure system and can have rapid pressure reductions without notice. The hazard comes when the pressure drops, the altimeter interprets this as a climb and will over-read. You may then have to descend slightly to maintain a cleared altitude. This means you have had to descend to maintain an indicated altitude, meaning your height, which is your actual distance from the ground, has reduced, putting you lower than you would normally be.

To remember this, we can say High to Low, lookout below. Meaning if we fly to lower pressure, we are closer to the terrain.

SUMMARY

In summary, there are a multitude of hazards accompanying a thunderstorm and they are to always be avoided when at all possible. If near to the airport as you are departing, it would be wise to delay takeoff until it has passed. If they are forecast at your destination, you’ll want an alternate airport ready and waiting, in case of a diversion.

MISSION ACCOMPLISHED

...or is it?

By completing the missions and ground school included with FS Academy - In Command, you have been exposed to the skills, knowledge and decisions that are demanded from the Captain.

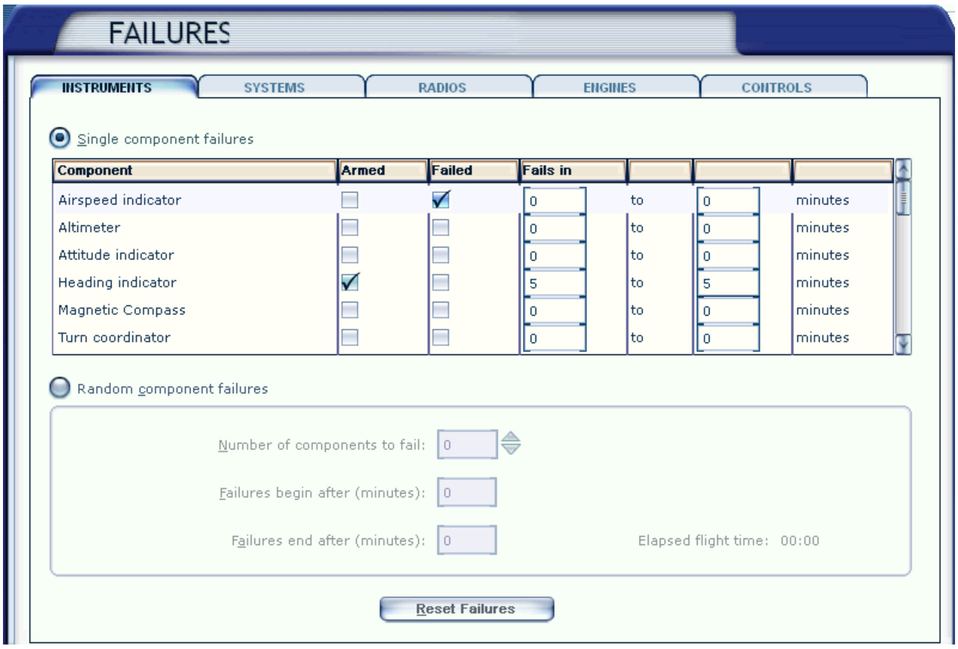
This is not the end of your journey, it is the beginning. The tools you have acquired are transferrable to practically any type of flying.

FSX allows you to create your own scenarios and emergencies, which you can tackle on your own terms. Our six missions here have the decision making demonstrated to you, bit now you can go onwards and decide for yourself what might be the best course of action.

SETTING FAILURES IN FSX

We'll cover how to set your own situations, to allow you to form your own decisions and plans.

On the Free Flight set up page in FSX, once you have decided upon which aircraft you'd like to use, click on the Failures button. You will be presented with the many possible system failures that can be triggered in FSX. On this screen you can set an aircraft system to be inoperative immediately, or arm it to fail later.



Here you can select from a multitude of possibilities, all giving rise to different challenges.

There are practically limitless combinations of situations available to you, from the same set of failures but in worse weather conditions or seeing how much you can cope with by setting a string of failures to really challenge yourself and your Command abilities.

Whatever scenarios you decide to create, remember the basics, keep an open mind and make sound, safe decisions.

Best of luck and safe landings.

ABBREVIATIONS

Aviation is absolutely awash with Abbreviated terms. This list will help you navigate a selection of the most common and useful to know abbreviations that will come up from time to time.

AAL	Above Airfield Level
ACARS	Aircraft Communications and Reporting System
ADF	Automatic Direction Finding
ADI	Attitude Direction Indicator
AER	Approach End Runway
ADS	Automatic Dependent Surveillance
AFB	Air Force Base
AFM	Aircraft Flight Manual
AGL	Above Ground Level
AGNIS	Azimuth Guidance Nose in Stand
AIAA	Area of Intense Aerial Activity
ALS	Approach Lighting System
AMM	Aircraft Maintenance Manual
AMSL	Above Mean Sea Level
APU	Auxiliary Power Unit
ASDA	Accelerate Stop Distance Available
ASI	Airspeed indicator
ASU	Air Start Unit
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilots Licence (UK)
ATR	Airline Transport Rating (USA & Canada)
BALS	Basic Approach Light System
BC	Patches
BR	Mist
C/S	Callsign
CAA	Civil Aviation Authority
CAS	Calibrated Airspeed
CAT	Clear Air Turbulence/Category
CAVOK	Cloud and Visibility OK
CB	Cumulonimbus
CDA	Continuous Descent Arrival
CDI	Course Deviation Indicator
CDL	Configuration Deviation List
CG	Centre of Gravity

CGL	Circling Guidance Lights
CLL	Centreline Lights
CPDLC	Controller-Pilot Datalink Communications
CPL	Commercial Pilots Licence
CRM	Crew Resource Management
CTR	Control Zone
CVR	Cockpit Voice Recorder
CWY	Clearway
DA	Decision Altitude
DCL	Departure Clearance
DER	Departure End of Runway
DFDR	Digital Flight Data Recorder
DH	Decision Height
DME	Distance Measuring Equipment
DST	Daylight Savings Time (Summer)
DU	Dust
DZ	Drizzle
EAS	Equivalent Airspeed
EASA	European Aviation Safety Agency
EAT	Expected Approach Time
ECAM	Electronic Centralised Aircraft Monitoring
EFB	Electronic Flight Bag
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indicating and Crew Alerting System
ELT	Emergency Locator Transmitter
EMDB	Embedded
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETOPS	Extended Range Twin Operations
ETP	Equal Time Point
EVS	Enhanced Vision System
EWH	Eye to Wheel Height
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FALS	Full Approach Lighting System
FANS	Future Air Navigation System
FAP	Final Approach Point
FAR	Federal Aviation Regulation
FBL	Feeble/Light
FC	Funnel Cloud/TAF with validity <12hrs
FD	Flight Director

FG	Fog
FL	Flight Level
FMC	Flight Management Computer
FMS	Flight Management System
FT	TAF with validity >12hrs
FU	Smoke
FZ	Freezing
GA	Go-Around/General Aviation
GMT	Greenwich Mean Time
GNSS	Global Navigation Satellite System
GP	Glidepath
GPU	Ground Power Unit
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GR	Hail
GS	Glideslope/Ground Speed
GS	Small Hail
H24	Applies 24hours
HDG	Heading
HG	Mercury
HIALS	High Intensity Approach Light System
HJ	Applies only in Daytime
HN	Applies only at Night
HP/hP	Holding Pattern/Hectopascals
HOT	Holdover Time
HSI	Horizontal Situation Indicator
HUD	Head Up Display
HURCN	Hurricane
HZ	Haze/Hertz
IAF	Initial Approach Fix
IAS	Indicated Airspeed
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IF	Intermediate Fix
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IM	Inner Marker
IMC	Instrument Meteorological Conditions
INOP	Inoperative
INS	Inertial Navigation System
IR	Instrument Rating
IRS	Inertial Reference System
ISA	International Standard Atmosphere
ITCZ	Inter Tropical Convergence Zone

JAA	Joint Aviation Authorities
KM	Kilometres
KT	Knots
LCTR	Locator
LDA	Landing Distance Available
LIAL	Low Intensity Approach Lighting
LMT	Local Mean Time
LNAV	Lateral Navigation
LOC	Localiser
LT	Local Time
LTNG	Lightning
LTS	Lower Than Standard
LVO	Low Visibility Operations
LVP	Low Visibility Procedures
MA	Missed Approach
MAPt	Missed Approach Point
MATZ	Military Air Traffic Zone
mb	Millibar
MBST	Microburst
MCDU	Multifunction Control and Display Unit
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MEA	Minimum Enroute Altitude
MEHT	Minimum Eye Height
MEL	Minimum Equipment List
MMEL	Master MEL
METAR	Meteorological Aerodrome Report
MFA	Minimum Flight Altitude
MGA	Minimum Grid Altitude
MHA	Minimum Holding Altitude
MI	Shallow
MIALS	Medium Intensity Approach Light Sys
MISAP	Missed Approach Procedure
MLW	Maximum Landing Weight
MLS	Microwave Landing System
MNPS	Minimum Navigation Performance Specifications
MOC	Minimum Obstacle Clearance
MORA	Minimum Off Route Altitude
MPS	Meters Per Second
MRA	Minimum Reception Altitude
MROT	Minimum Runway Occupancy Time
MSA	Minimum Safe Altitude
MSL	Mean Sea Level

MTCA	Minimum Terrain Clearance Altitude
MTOW	Maximum Takeoff Weight
MVFR	Marginal VFR
MZFW	Maximum Zero Fuel Weight
NADP	Noise Abatement Departure Procedure
NALS	No Approach Light System
NAVAID	Navigational Aid
NCD	No Cloud Detected
NDB	Non-Directional Beacon
NM	Nautical Mile
NOSIG	No Significant Change
NOTAM	Notice to Airmen
NPA	Non-Precision Approach
NSC	Nil Significant Cloud
NSW	Nil Significant Weather
NTZ	No Transgression Zone
OAT	Outside Air Temperature
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OCNL	Occasional
OEI	One Engine Inoperative
OFP	Operational Flight Plan
OM	Outer Marker
OTS	Other Than Standard
OVC	Overcast
PALS	Precision Approach Lighting System
PANS	Procedures for Air Navigation Services
PAPI	Precision Approach Path Indicator
PAX	Passengers
PBN	Performance Based Navigation
PCL	Pilot Controlled Lighting
PCN	Pavement Classification Number
PDC	Pre-Departure Clearance
PDG	Procedure Design Gradient
PFD	Primary Flight Display
PIC	Pilot in Command
PL	Ice Pellets
PN	Prior Notice Required
PO	Dust/Sand Whirls
POB	Persons on Board
PRFG	Partial Fog
PRNAV	Precision Area Navigation
PROB	Probability

QDM	Magnetic Heading to Station
QDR	Magnetic Bearing from Station
QFE	Air Pressure at Airfield Level
QFU	Magnetic Orientation of Runway
QNH	Air Pressure at Sea Level
QRH	Quick Reference Handbook

RA	Rain
RAIL	Runway Alignment Indicator Lights
RAIM	Receiver Autonomous Integrity Monitoring
RASN	Rain and Snow
RCLL	Runway Centreline Lights
RCLM	Runway Centerline Markings
REDL	Runway Edge Lights
REIL	Runway End Indicator Rights
RENL	Runway End Lights
RET	Rapid Exit Taxiway
RFFS	Rescue and Fire Fighting Services
RIL	Runway Identification Lights
RMI	Remote Magnetic Indicator
RMK	Remark
RNAV	Area Navigation
ROC	Rate of Climb
ROD	Rate of Descent
RSC	Runway Surface Condition
RTIL	Runway Threshold Identification Lights
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minima

SA	Sand
SAR	Search and Rescue
SCT	Scattered
SEV	Severe
SELCAL	Selective Calling
SFC	Surface
SG	Snow Grains
SH	Showers
SI	International System of Units
SID	Standard Instrument Departure
SIGMET	Significant Meteorological Information
SIGWX	Significant Weather
SKC	Sky Clear
SLP	Speed Limiting Point
SM	Statute Miles
SMC	Surface Movement Control
SNOCLO	Airport Closed due to Snow
SQ	Squall

SRA	Surveillance Radar Approach
SS	Sandstorm
STAR	Standard Terminal Arrival Route
SWY	Stop way
TA	Transition Altitude
TAF	Terminal Area Forecast
TAS	True Airspeed
TC	Tropical Cyclone
TCAS	Traffic Alert and Collision Avoidance System
TCH	Threshold Crossing Height
TCU	Towering Cumulus
TDO	Tornado
TDZ	Touchdown Zone
TECR	Technical Reason
TEMPO	Temporary
TL	Transition Level
TS	Thunderstorm
U/S	Unserviceable
UAV	Unmanned Aerial Vehicle
UNREL	Unreliable
UTC	Coordinated Universal Time
VA	Volcanic Ash
VASI	Visual Approach Slope Indicator
VC	Vicinity
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VMCA	Minimum Control Speed (Airborne)
VOLMET	Weather reports for aircraft inflight
VOR VHF	Omnidirectional Range
VPT	Visual Manoeuvre with Prescribed Track
VRB	Variable
VV	Vertical Visibility
WEE	Whichever is Earlier
WEL	Whichever is Later
WGS-84	World Geodetic System 1984
WIP	Work in Progress
WKN	Weakening
WS	Windshear
WTH	Wheel to Threshold Height
WX	Weather
WXR	Weather Radar
XPDR	Transponder