Aircraft Handling and Flying Techniques Index

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Aircraft Handling and Flying Techniques

Learning Outcome 1

Reference: AP3456 Vol 5, Pt 1, Sec 1

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LO1 Know about aircraft maintenance and ground handling techniques

- P1 - Outline the reasons and objectives for aircraft maintenance
- P2 - Describe what is meant by aircraft modifications
- P3 - Outline ground handling techniques
- P4 - Identify hazards and risks when ground handling aircraft

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P1 - Outline the reasons and objectives for aircraft maintenance

RAF Maintenance Policy

- A balance of *preventative* and *corrective* maintenance

Objectives

- Maintenance Objectives
- Operational Objectives

P1 - Outline the reasons and objectives for aircraft maintenance

Operational Objectives

- Generate aircraft and equipment to meet:
  - A counter-surprise alert
  - NATO and national commitments
- Support intensive flying operations in hostile/NBC environments
- Satisfy contingency plans
- Provide serviceable aircraft and equipment to meet peacetime needs

P1 - Outline the reasons and objectives for aircraft maintenance

Maintenance Objectives

- Minimize faults
- Minimize the manpower and resources required
- Identify methods for improving reliability and maintainability

P1 - Outline the reasons and objectives for aircraft maintenance

Maintenance Types

- Preventative Reduces probability of failure
  - Servicing
  - Scheduled maintenance
  - Out of Phase maintenance
  - Condition-based maintenance

- Corrective After a fault has occurred

- Contingency In the transition to war

P2 - Describe what is meant by aircraft modifications

Modifications of an aircraft:

- Enhance operational capability
- Improve reliability
- Reduce servicing costs

Modifications are an integral part of maintenance policy as embodiment would:

- Raise costs
- Increase aircraft downtime
- Effect equipment availability

Modifications need special authority and must be closely monitored

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P3 - Outline ground handling techniques

Seeing In/Off

Aircraft are seen in/off by a handling team of usually two tradesmen.

Handling Team Responsibilities:

- Marshalling
- Inserting/removing chocks
- Attaching/removing ground power
- Positioning and manning fire extinguishers
- Positioning steps
- Fitting/removing safety devices, covers and blanks

P3 - Outline ground handling techniques

Marshalling Signals

Assists the pilot in the safe manoeuvring of aircraft on the ground

Signals are standard throughout the RAF iaw STANAG 3117 (Standard NATO Agreement)

Pilot is always responsible for the safety of the aircraft
- Not required to follow marshalling instructions considered unsafe

P3 - Outline ground handling techniques

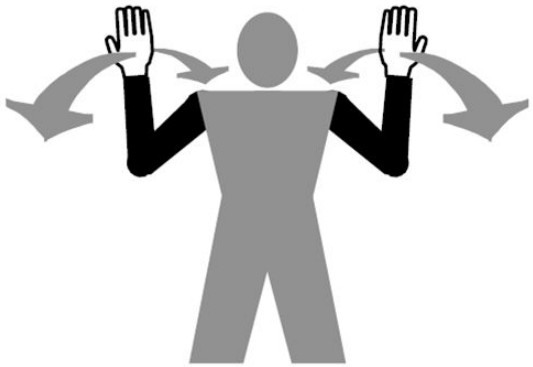
Marshalling Signals

Move ahead

MOVE AHEAD

DAY: Arms a little apart, palms facing backwards and repeatedly moved upward-backward from shoulder height.

NIGHT: Same as day signal with wands held as extension of arms.



P3 - Outline ground handling techniques

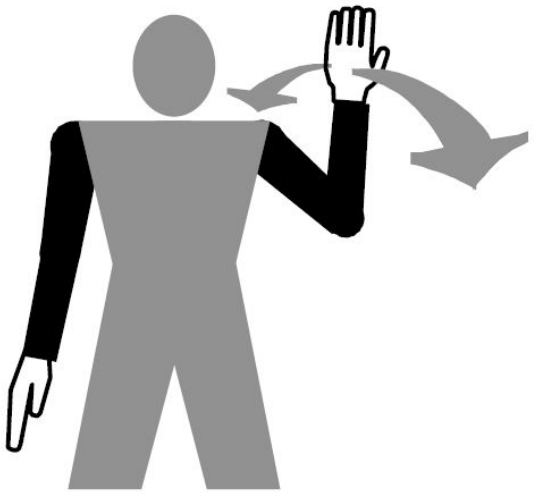
Marshalling Signals

Turn Left

TURN TO LEFT

DAY: Point right arm downward, left arm repeatedly moved upward and backward. Speed of arm movement indicating rate of turn.

NIGHT: Same as day signal with wands held as extension of the arms.



P3 - Outline ground handling techniques

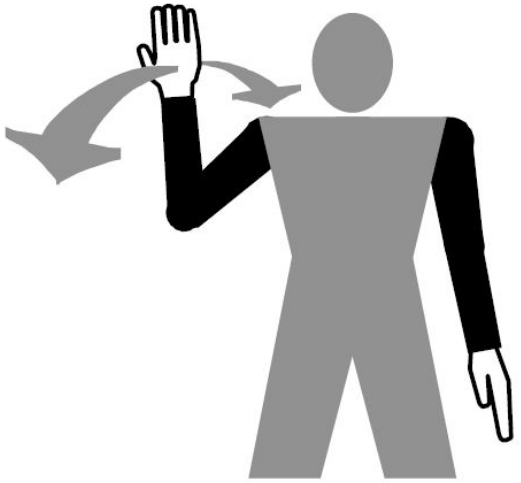
Marshalling Signals

Turn Right

TURN TO RIGHT

DAY: Point left arm downward, right hand repeatedly moved upward and backward. Speed of arm movement indicating rate of turn.

NIGHT: Same as day signal with wands held as extension of arms.



P3 - Outline ground handling techniques

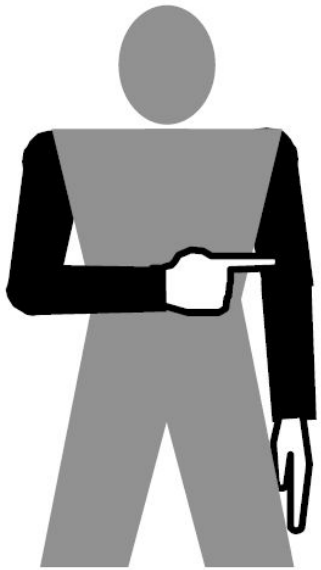
Marshalling Signals

Proceed to Next Marshaller

PROCEED TO NEXT MARSHALLER

DAY: Right or left arm down, other arm moved across the body and extended to indicate direction to next marshaller.

NIGHT: Same as day signal with wand held as an extension of the arms.



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P3 - Outline ground handling techniques

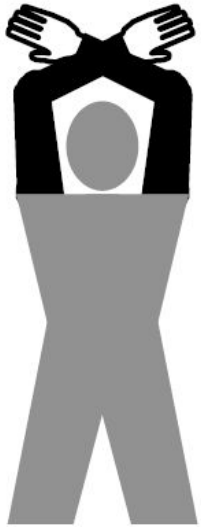
Marshalling Signals

Stop

STOP

DAY: Arms crossed above the head, palms facing forward.

NIGHT: Same as day signal with wands held as extension of arms.



P3 - Outline ground handling techniques

Marshalling Signals

Brakes

BRAKES

"ON" DAY: Arms above head, open palms and fingers raised with palms toward aircraft, then fist closed.

"ON" NIGHT: Arms above head then wands crossed.

"OFF" DAY: Reverse of above.

"OFF" NIGHT: Cross wands, then uncrossed.

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P3 - Outline ground handling techniques

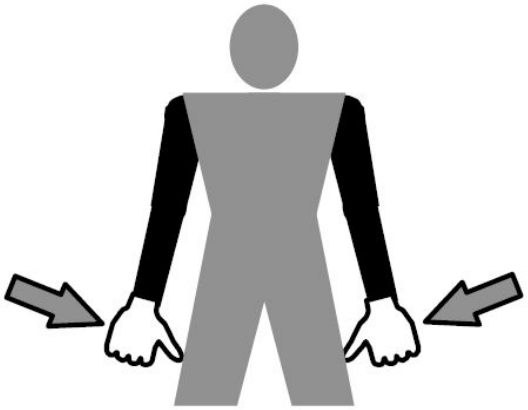
Marshalling Signals

Insert Chocks

INSERT CHOCKS

DAY: Arms down, fists closed, thumbs extended inwards, swing arms from extended position inwards.

NIGHT: Same as day signal with wands held as extension of arms.



P3 - Outline ground handling techniques

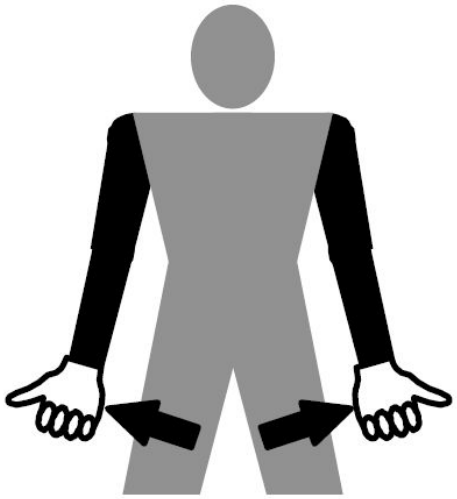
Marshalling Signals

Remove Chocks

REMOVE CHOCKS

DAY: Arms down, fists closed, thumbs extended outwards, swing arms outwards.

NIGHT: Same as day signal with wands held as extension of arms.



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P3 - Outline ground handling techniques

Marshalling Signals

Insert Ground Power

GROUND-ELECTRICAL POWER SUPPLY INSERT

DAY: Hands above head, left fist partially clenched, right hand moved in direction of left hand with first two fingers extended and inserted into circle made by fingers of the left hand.

NIGHT: Same as day signal with left wand held vertical and right wand held horizontal.

P3 - Outline ground handling techniques

Marshalling Signals

Disconnect Ground Power

GROUND-ELECTRICAL POWER SUPPLY DISCONNECT

DAY: Hands above head, left fist partially clenched, right hand moved away from left hand, withdrawing first two fingers from circle made by fingers of the left hand.

NIGHT: Same as day signal with left wand held vertical and right wand held horizontal.

P3 - Outline ground handling techniques

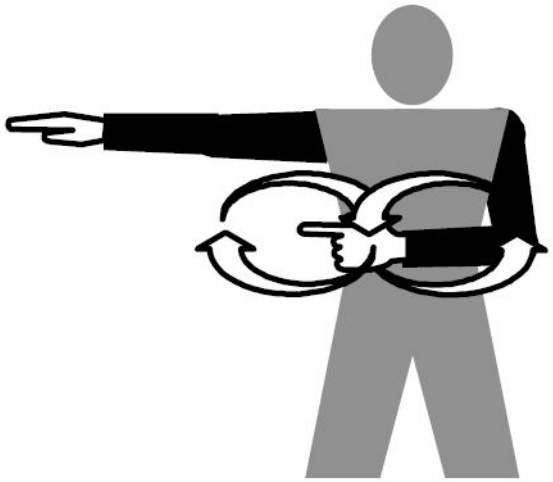
Marshalling Signals

Fire

FIRE

DAY: Make rapid horizontal figure-of-eight motion at waist level with either arm, pointing at source of fire with the other.

NIGHT: Same as day signal with wands held as extension of arms.



P3 - Outline ground handling techniques

Marshalling (continued)

By day

- Once parking space is given pilot is free to taxi as required
- If obstructions exist two extra personnel may be required to clear the wingtips (most likely with larger aircraft)

By night

- Marshallers usually use lighted wands
- Aircraft navigation and taxi lights should be on
- If pilot loses sight of marshaller, aircraft should be stopped

P3 - Outline ground handling techniques

Fuel

Main types:

- AVGAS - Aviation Gasoline (piston engine aircraft)
- AVTUR - Aviation Turbine (gas-turbine engines)
- AVTAG - Freezing point lower than AVTUR
  - Emergency military use only
- AVCAT - Higher flashpoint than AVTUR
  - Largely used by Royal Navy

Delivery methods:

- Bowsers – most common
- Hydrants – Mainly civilian airfields
- Portable Tanks – may be used when operating from a temporary base

P4 - Identify hazards and risks when ground handling aircraft

Danger Zones

Areas of high risk of injury to personnel when aircraft are operated on the ground

- Engine intakes/exhausts
- Propellers
- Helicopter rotors (including tail rotor)
- Control surfaces and airbrakes

Propellers should always be considered as ‘live’
Helicopter rotors in windy conditions could experience ‘blade sailing’ – may bring rotor tips close to the ground.

P4 - Identify hazards and risks when ground handling aircraft

Wheel and brake fires

Danger of explosion

Stay away from the axle line (3-9 line)

Insert picture showing 3-9 line

P4 - Identify hazards and risks when ground handling aircraft

Precautions whilst refuelling

- Adequate fire cover required
- Aircraft bonded and earthed to reduce static sparks
- Refuelling crews wear rubber-soled shoes if possible
- No naked lights
- No R/T transmissions
- Refuelling vehicles positioned so they can be quickly moved in the event of a fire

Ground Handling

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Recap

- Aircraft Maintenance
- *Ground Handling*

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Seeing in & Seeing off

- Aircraft arrivals and departures are usually attended by a handling team comprising two tradesmen.
  - The handling team will marshal an arriving aircraft into a parking area which has been cleared of FOD
  - When signalled by the aircraft captain, chocks are inserted and ground power and any necessary ground servicing equipment is connected.
  - Fire extinguishers are positioned and manned as required during engine shut-downs
  - Aircraft steps are positioned and the aircrew are assisted with unstrapping.
  - The handling team will then fit safety devices (eg safety pins to make the ejection and any other covers, blanks and plugs that are needed – eg cover or sleeve over the pitot head, a plug for the static vent).

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Marshalling

- The extent of the marshalling assistance given will depend upon:
  - the pilot's familiarity with the airfield,
  - the number of obstructions,
  - the size of the aircraft
  - the field of view from the cockpit.
- At an unfamiliar airfield taxiing instruction can be passed by radio;
- For a long route, marshallers may be stationed at intervals, or "follow me" vehicles may be used.
- The pilot is responsible for the safety of the aircraft and is not required to comply with marshalling instructions he considers to be unsafe.

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Day Marshalling

- Marshalls identify themselves to pilots by energetic waving of the arms in a circular motion & wearing hi-vis clothing.
- The Marshalls may indicate where the aircraft must finally be stopped by standing on the required spot with arms outstretched, facing towards the final position of the aircraft.
- The pilot is then free to taxi the aircraft in a path of his own choosing to the spot indicated.
- If obstructions exist, two extra personnel may be required to walk ahead of the aircrafts wing tips and signal to the pilot if there is sufficient clearance for the aircraft to pass the obstructions.

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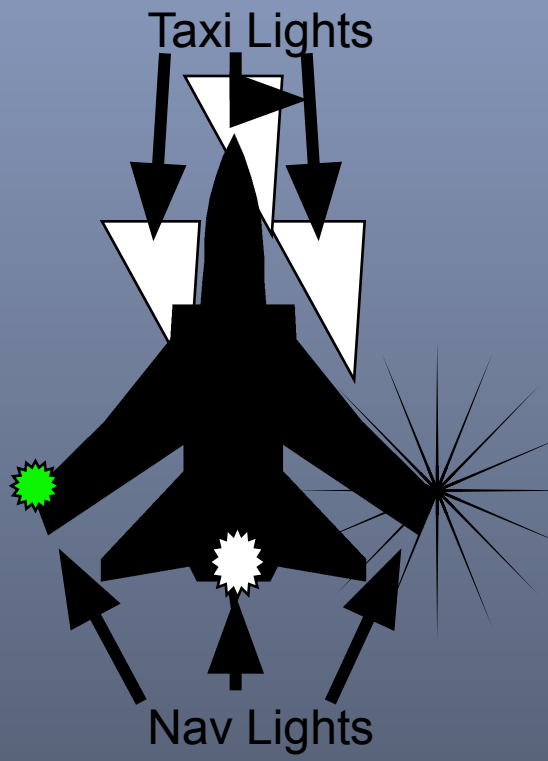
Night Marshalling

- Taxiing at night requires more detailed marshalling directions
- If dispersal areas are floodlit, marshalling assistance can be reduced to that given in daylight.
- Navigation lights must always be on, and taxi lights used
- Care should be taken not to dazzle the marshaller
- Marshallers carry wands or torches for identification and must be visible at all times by the pilot.
- If the pilot looses sight of the marshaller they must stop and wait for them to catch up.



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Danger Zones

- Danger zones are those areas in which there is a high risk of injury to personnel when aircraft components or systems are operated on the ground.
- Danger zones include:
  - engine intakes - sucking
  - Engine exhausts – blowing & hot
  - propellers – always considered as “live”
  - helicopter rotors – prone to “blade sail” where they rotate and bring the blades closer to ground height.

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Wheels, brakes & fires

- Aircraft wheel brakes are made of two components:
  - a pad of heat-resistant and hard-wearing fibre presses
  - a disc attached to the wheel (or it may be a drum instead of a disc in some simple aircraft).
- The friction between the pad and disc slows the aircraft.
- Friction heats up the disc – which can, in prolonged taxiing, abnormal loading or heavy landing can cause a fire.
- The Marshalling team are in charge of this until the Fire Service arrives. The safest course of first aid action against an aircraft wheel or brake fire is:
  - To stand forward or rearward of the wheels depending on the prevailing wind, but never in line with the axle
  - To operate the fire extinguisher at the limit of its range, and to spray the extinguishing downwards 0.3m away from the wheels

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Manhandling & Towing

- Aircraft are never taxied in to or out of hangers – they are towed or manhandled instead
- The tow vehicle connects to the aircraft by a fixed towbar to the wheel or nose. If manhandled it is moved by pushing on strong areas - not control surfaces
- Handling parties must be qualified and consist of:
  - An experienced supervisor.
  - One person in the cockpit to operate the brakes when required.
  - One at each wing tip to ensure obstacle clearance.
  - Either a driver for the towing vehicle, or a sufficient number of persons to manhandle the aircraft.

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Parking Process

1. Park the aircraft facing into wind
2. Ensure that no part of one aircraft overlaps any part of another.
3. Double chock the wheels – fore and aft.
4. Release the brakes.
5. Check the electrical services, ignition switches and fuel cocks are turned off.
6. Apply control locks.
7. Fit pitot and static vents covers.
8. Lock canopies and doors, fit canopy, wheel and engine covers and set drip trays.

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Fuel & Refuelling

- The RAF and RN have 4 types of fuel:
  - AVGAS – aviation gasoline.
  - AVTUR – aviation turbine fuel (kerosene).
  - AVTAG – aviation turbine widecut gasoline.
  - AVCAT – aviation turbine fuel, used largely by the RN.

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Fuel & Refuelling

- Aircraft are normally refuelled after every sortie or before it is parked/hangared to stop condensation forming inside the tank. This also reduces the setup time for future sorties.

Aircraft may be refuelled in many ways:

- Jerry can
- Browsers
- High pressure from ground tanks
- Hand or mechanical pump from ground or portable tanks
- Air-Air Refuelling (AAR)

Static electricity can cause sparks leading to a fire; to reduce this the aircraft, pumping equipment & hose are is earthed

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Refuelling – Local Orders

- Other precautions must be taken are laid out in the local orders:
  - Correct grades of fuel and oil are put into the appropriate tanks.
  - Leave air space in oil tanks for expansion of oil when heated.
  - Never refuel an aircraft in a hangar or with the engine running
  - Always filter the fuel
  - No cigarette lighters or matches around the aircraft
  - Wear rubber or crepe soled shoes.
  - Avoid fuel spillages - call a fire tender if one occurs.
  - 15m exclusion zone for working on electrical or RT equipment
  - 40m exclusion zone for aircraft with engines running
  - Emergency escape routes for refuelling vehicles.
  - Place suitable fire extinguishers ready for use.
  - Stand only on the approved walkways on the aircraft.
  - Replace filter caps and check they are fitted properly.
  - Enter details of the refuelling/defuelling in MOD Form 705.

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Refuelling – Pressure Refuelling

- Pressure refuelling is AAR & Tactical Operations such as Harriers & Support Helicopter Force (SHF).
- In pressure refuelling the nozzle makes a fuel tight fit with the aircraft. This allows higher pressure & faster delivery of fuel.
- All systems have shut off valves to prevent over filling.
- Bonding precautions are still required
- Aircraft can be refuelled by this method with their engines running (hot refuelling) – but strict precautions must be followed.

Loading

- Large aircraft have an Air Load Master / Air Quartermaster, whose responsibilities include:
  - Supervising the loading process
  - Securing loads
  - Ensuring the centre of gravity (C of G) is within limits.
  - Satisfying the Captain of these
- Overloading has the following effects:
  - Increases take off & landing distances.
  - Increases the stalling speed
  - Reduces rate of climb.
  - Reduces range
  - Reduces endurance.
  - Reduces the aircraft's ceiling height
  - In twin or multi-engined aircraft it may make it impossible to maintain flight in the event of an engine failure.
- Each of these ensures the aircraft is safe to fly

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Preparation for Flight

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Recap

- Aircraft Maintenance
- Ground Handling
- *Prep for Flight*

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The Captain

- The Aircraft Captain is in overall responsibility of the aircraft
  - The Captain has supreme charge in an emergency
  - They must be a good leader
  - Any member of an aircraft crew may be appointed as the captain
  - Normally this appointment is most often held by the pilot

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Flight Preparation

- The Captain must ensure flight preparation for themselves & their crew:
  - Familiarity with aircraft, their roles, their training & their confidence
  - The aim of the flight
  - The personal fitness of themselves & crew members
  - The relevant order books have been read and understood: Military Flying Regulations, Air Staff Instructions and the Station Flying Order Books
  - The flying clothing and safety equipment of themselves and crew members is complete and in good repair – and that serviceability checks have been completed.
  - Flight planning & navigation checks are complete

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Flight Planning

- Flight Planning requires knowledge of:
  - The weather conditions at the time and a forecast of how the weather is likely to change during the flight.
  - ATC clearance, details of available diversion airfields and restricted airspace's in the region of the flight.
  - Navigation pre-calculations and preparation of maps and charts.
- "Self briefings" enable the Pilot/Nav to use Met and ATC info displayed in the Ops/flight planning room to complete the flight plan and prepare maps and charts.
- Many units hold a mass briefing for all aircrew at the start of the day's flying; the Sqn OC, ATC, Wx and other departments brief crews on their areas.

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Passenger Briefing

- The Captain is responsible for ensuring passengers are briefed – this may be delegated to an Air Loadmaster if present.
- The items to be covered will vary but typically include:
  - That the captain of the aircraft is in command of the aircraft and all persons in it, irrespective of rank, whilst in flight.
  - Use of the safety straps, the crash and ditching positions.
  - Escape hatches and dinghy positions where ditching.
  - Fitting oxygen masks & operate the oxygen flow controls.
  - Fitting and operate parachutes.
  - Smoking & naked flame rules when applicable.
  - Operating any R/T communication equipment

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Flight Authorisation, Form 3562

- No pilot may fly without formal authorization of the flight
- An officer (Sqn OC, Flt Cdr) authorises a sortie in the Flight Authorization Book (Form 3562) after considering:
  - Weather conditions
  - Experience of the crew
  - The instrument flying rating of the pilot
  - The equipment available in the aircraft
  - The facilities available at the destination
- The 3562 & Form 700 can be impounded for investigation if an accident happens.
- The captain signs the 3562 to confirm their responsibilities and the restrictions on the sortie.
- The 3562 is the official record of flying times & exercises carried out. The captain signs it at the end of the sortie.

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MOD 700 Series

- The captain signs the Form 705 before a sortie. Their signature certifies that:
  - Flight servicing has been carried out.
  - The aircraft is now shown as serviceable.
  - The time remaining unexpired before the next scheduled servicing is sufficient for completion of the proposed flight.
  - The quantities of fuel, oil, oxygen and armament are sufficient for the flight.
  - They are aware of work done on the aircraft since its last flight.
  - It has been signed by the Flight Services Co-ordinator.
- The captain fills in and signs the form on completion of the flight to certify whether the aircraft is “satisfactory” or not for the sortie.

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Pre-Flight Checks

- On approaching the aircraft the pilot will note:
  - Position in relation to other aircraft
  - Position in relation to obstructions
  - Routes to the taxiway
  - FOD
  - Whether clear to start engines
  - Condition of ground
  - Aircraft is properly chocked
  - Aids to starting engines properly positioned
  - Starting crew & fire extinguishers in place
- Detailed checks for the type of aircraft will be found in the Aircrew Manual for the type, but will normally include:
  - External checks.
  - Cockpit checks before starting engines.
  - Warming up and running up (piston engines).
  - Pre-take off checks.

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Pre-Flight Checks

- Checks may often be in “card” form and are “called off” to the pilot by another crew member by challenge and response.
- Checks are a pre-requisite of every flight
- Checks are integral to the team work that goes into preparing the aircraft and crew for flight.
- They are the final steps in ensuring that all is ready for take off.

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External Checks

- A properly completed Form 700 series is an assurance that the aircraft has been serviced
- It is good airmanship & good practice for a pilot to inspect the outside of the aircraft to ensure it is aerodynamically and operationally fit for flight. They will:
  - Check inside the cockpit to ensure that brakes are on and switches are off.
  - Walk right round the aircraft, checking the surfaces of fuselage, wings & tail plane for signs of damage, ice, hydraulic fluid, fuel or oil leaks, and check fastenings of inspection panels.
  - Check pitot head and static vent covers have been removed
  - Check external control locks, external undercarriage locks, engine covers and blanking plates have been removed
  - Inspect the undercarriage for serviceability, noting signs of damage or excessive wear in tyres and wheels.

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Checks before starting

- Starting engines is a team procedure between the pilot and the ground handling team.
- Before starting the Captain will ensure that:
  - They, the crew and passengers are correctly seated and strapped in.
  - He will then check the cockpit to ensure that fuel and other services required are switched on
  - The undercarriage is selected down and is shown as being locked down
  - The brakes are locked on and pressurised
  - The engines are switched as required.
- The pilot will then indicate the engines ready to be started by shouting “All clear for starting?”. The Ground crew will then check it is clear.
- The pilot then repeats this before starting the engine.

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Checks after starting

- Engine checks after start-up vary according to type.
- Piston engines
  - Check that the oil pressure registers on the gauge.
  - Engine warmed to the cylinder head and oil temps.
  - Run engine to higher rpm, to test the power output, functioning of magnetos and operation of the propeller variable pitch control.
  - This may be done at dispersal or may be done after taxiing to the marshalling point at the runway in use.
- Jet Engines
  - Jet engines do not require warming up
  - There is a brief period during start-up, whilst the engine is winding up to idling rpm and the flame is not fully stabilized
  - If the temperature is rising too rapidly the engine must be closed down before the permitted maximum is exceeded – otherwise engine damage can occur or a fire could break out.

Taxiing – Prelims & Speeds

- Any special points to be watched while taxiing are described in the Aircrew Manual for the aircraft type.
- In general:
  - The pilot must check the brakes ASAP after starting to taxi whilst the speed is still low.
  - The pilot will always keep the amount of engine power used in taxiing as low as possible, since aircraft brakes can quickly overheat if abused.
- Taxiing speeds depend entirely on he circumstances
- The overall consideration must be to limit the speed to:
  - give time to cope with any emergency
  - to limit the stresses on the undercarriage
  - Any obstructions or turning sharply.

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Taxiing Steering

- If the aircraft has nose wheel steering, wheel brakes will be used only to slow or stop the aircraft.
  - In aircraft without nose wheel steering, the pilot has to use the brakes to steer the aircraft - left brake to turn left
  - The application of brake to one wheel and not the other, in order to steer the aircraft is called “differential braking”.
- In tail wheel aircraft, where the CoG is behind the main wheels, there is a tendency for a turn, once started, to tighten up.
- In nose wheel aircraft, where the CoG is ahead of the main wheels, a natural directional stability results and the turning force has to be maintained to sustain the turn.

Taxiing Wind

- The wind velocity can be an important consideration when taxiing.
- The effect of the wind on the keel surfaces (ie the fin and rudder) normally tends to turn an aircraft into wind – the “weather cock” effect.
- In a strong wind, the effectiveness of the brakes in countering weather cocking may well be the limiting factor in the use of these aircraft.
- In strong or gusty winds the controls must be held firmly to prevent them being blown against their stops;
- Aircrew Manuals indicate when control locks may be used when taxiing.

Taxiing - Obstructions

- The pilot must keep a good look-out for obstructions and other aircraft at all times when taxiing
- In a large aircraft it is normal to post crew members in suitable positions in the aircraft to supplement his look out
- In single piston engine aircraft the pilot's forward view is restricted by the nose:
  - As such they must taxi slowly
  - Yaw the nose from side to side to ensure that the way ahead is clear.
- In any aircraft, if doubt exists about the clearances or position of obstacles, the aircraft should be stopped

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Pre-take-off checks

- "Pre-take-off checks" are vital to the safety of the aircraft
- The actions following PTOCs are called "vital actions"
- The PTOCs ensure equipment for successful take-off and climb away is functioning and set correctly:
  - the supply of fuel to the engine
  - the position of the flaps
  - the operation of the flight instruments
  - plus others
- PTOCs are generally double checks of previous checks – but they are the final checks before take off
- In multi-crew aircraft the checks are done on "challenge and response" basis
- In single-seat aircraft the pilot does them from memory

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General Flying

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Recap

- Aircraft Maintenance
- Ground Handling
- Prep for Flight
- *General Flying*

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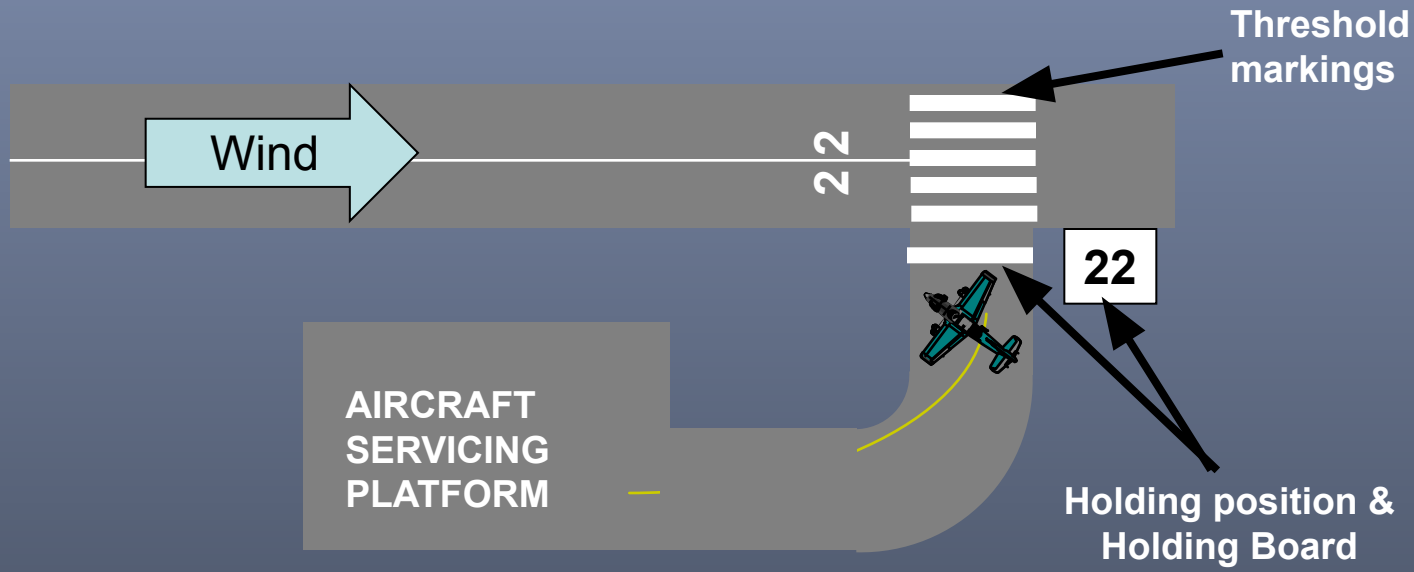
Holding Position

- The Holding position is a white line at the across the end of the taxi way which separates it from the runway
- It gives the pilot a good view of the runway, and the finals approach
- Light aircraft normally turn about 45º into wind, whilst large aircraft are stopped heading along the taxiway



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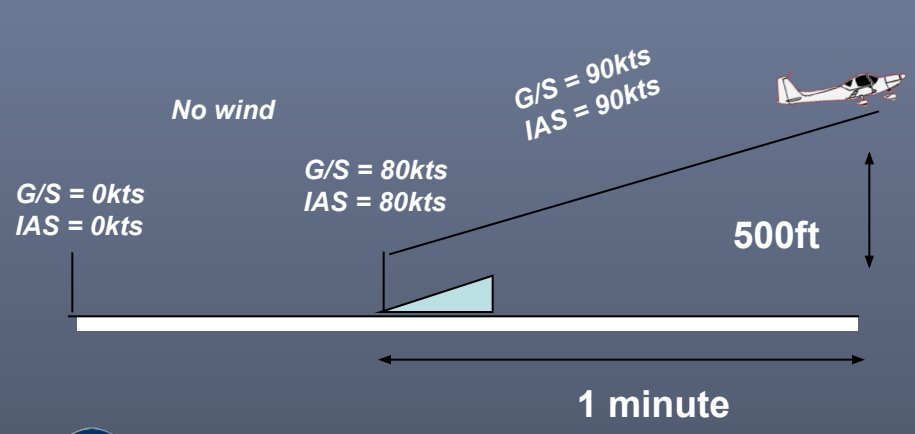
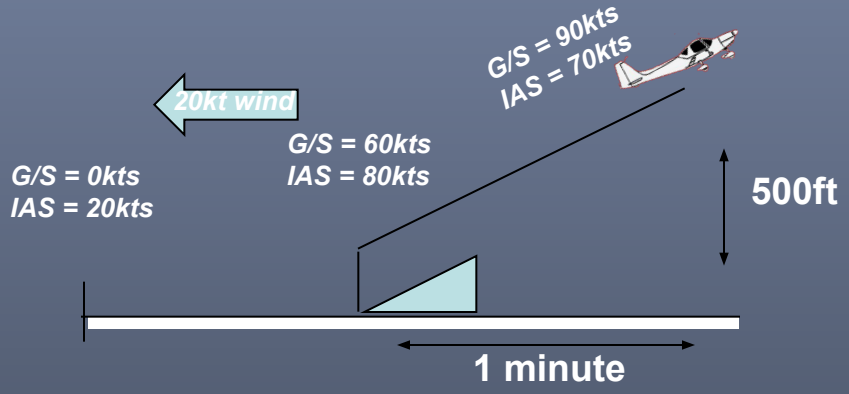
Checks & Throttle on

- Before taxiing onto the runway in the use a pilot must:
  - complete his **Vital Actions**
  - receive permission from the controller
  - check that the approach is clear
  - the flying controls must be tested for motion & response
- Near the holding position is the runway controller's caravan who's duties are:
  - to scrutinize aircraft about to take-off,
  - Check for signs of danger such as loose panels, fuel leaks, oil leaks, and hydraulic leaks.
- Full throttle is **always** used for take-off to obtain full power ASAP. Reheat causes extra acceleration.
- Engine instruments must be monitored to ensure the engines remain within their limits.

Take off length: Wind

- Wind is one of the most crucial factors affecting take-off:
  - **Wind velocity**
    - A 20 kt wind has an (IAS) of 20 kts before it starts moving
    - Steeper angle of climb after becoming airborne
    - Lower ground speed at take off reduces undercarriage & tyres stress
    - Lower drift tendency
    - Improved directional control in the initial stages of take-off.





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Take off length

- The length of the take-off run depends on:

  - **All-up weight** – more weight means more lift which means more speed gained by increasing run up
  - **Amount of flap used** – higher co-efficient of lift enables the aircraft to take off at a lower Indicated Air Speed (IAS)
  - **Engine power** – greater thrust means faster take off
  - **Runway gradient –** Uphill = less acceleration = longer-take-off.

Take off length

- **Runway surface –** Snow, ice, slush, grass, pot holes, mud all increase friction, decrease acceleration & increase take off.
- **Air temperature –**
  - High air temp reduces the air density reducing lift at a given airspeed.
  - Thrust can be reduced by 4 & 5% per 5ºC above 15ºC.
- **Airfield elevation –**
  - Reduced air density at high altitude increases the length of take-off
  - High altitude airfields in the tropics have lengthened runways to allow for the reduced lift and decreased engine performance.

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Wind Velocity

- The length of the take-off run depends on:
  - **Runway gradient –** Uphill = less acceleration = longer-take-off.
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Take Off Techniques

Nose Wheel aircraft

- Vital Checks
- Taxi forward to straighten nose wheel
- Open throttle to max
- Steer with brakes initially, move to rudder
- Raise nose slightly
- Check instruments
- Reach take off speed
- Raise nose fully

Tail wheel aircraft

- Vital Checks
- Taxi forward to straighten tail wheel – lock if rqd
- Open throttle to max
- Steer with rudder initially, decreasing movement with speed
- Drop nose slightly to increase speed, lifting tail
- Check instruments
- Reach take off speed
- Raise nose

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Actions when airborne

- **Actions when Airborne**
  - Apply brakes (stop wheels rolling in storage)
  - Retract & lock undercarriage before maximum speed is reached
  - Shallow climb is maintained
  - Raise IAS to initial climbing speed.
  - Raise flaps (if used)
  - Reduce power to normal climbing power
- **Use of Reheat**
  - Raise flaps & undercarriage ASAP
  - Acceleration from reheat can exceed the limits of the above

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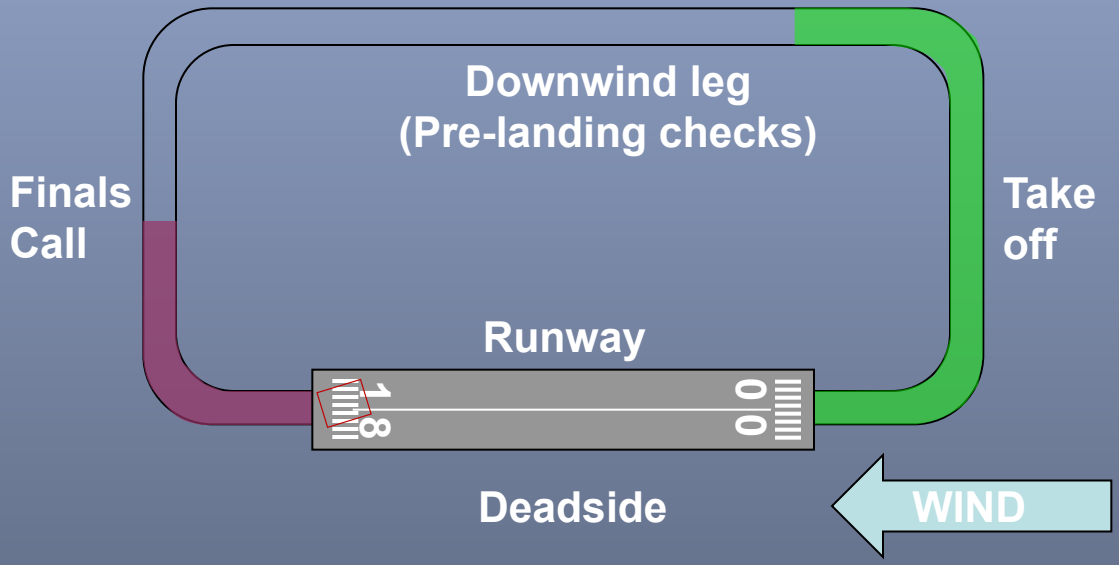

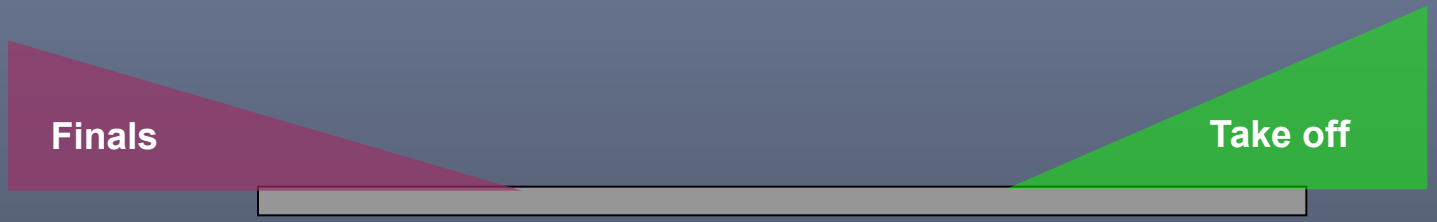

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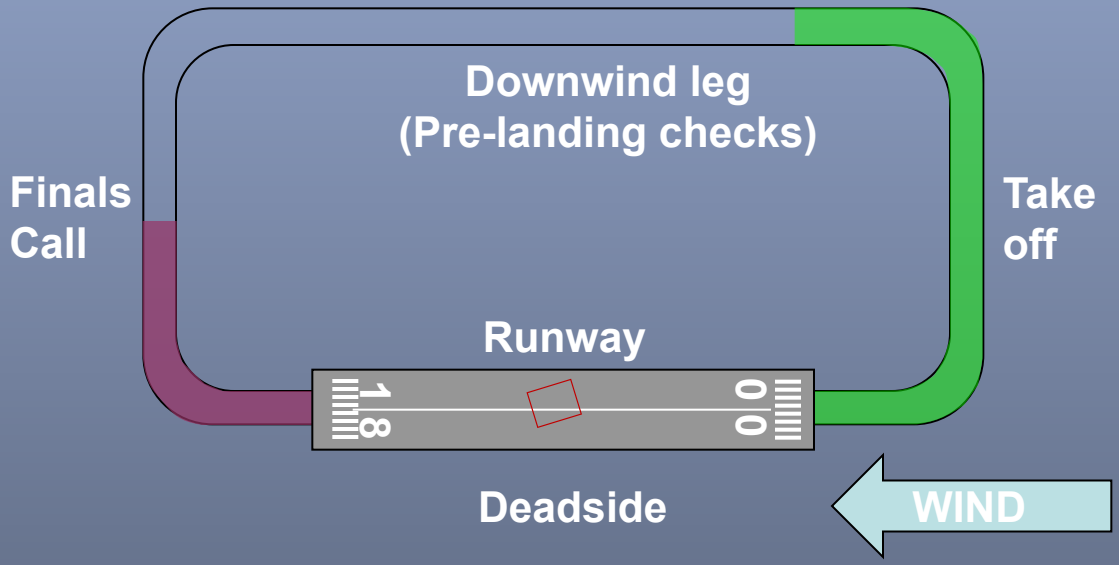

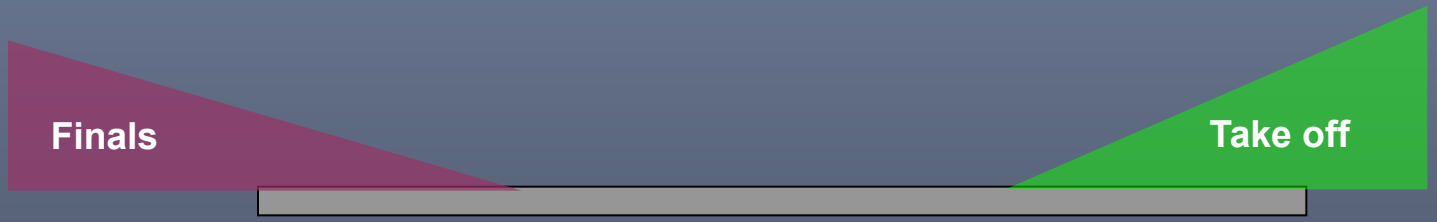

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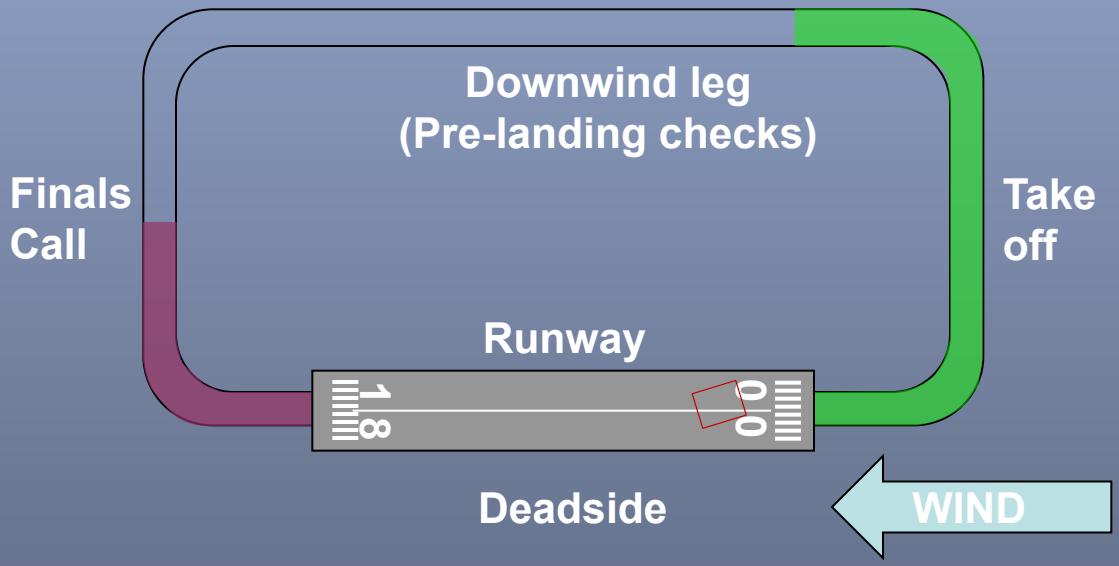

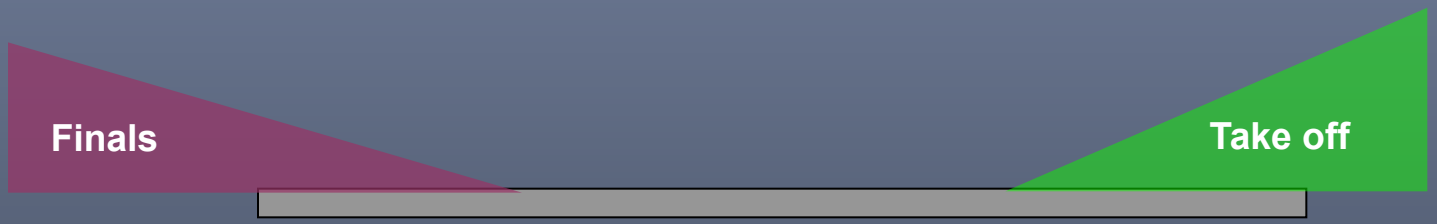

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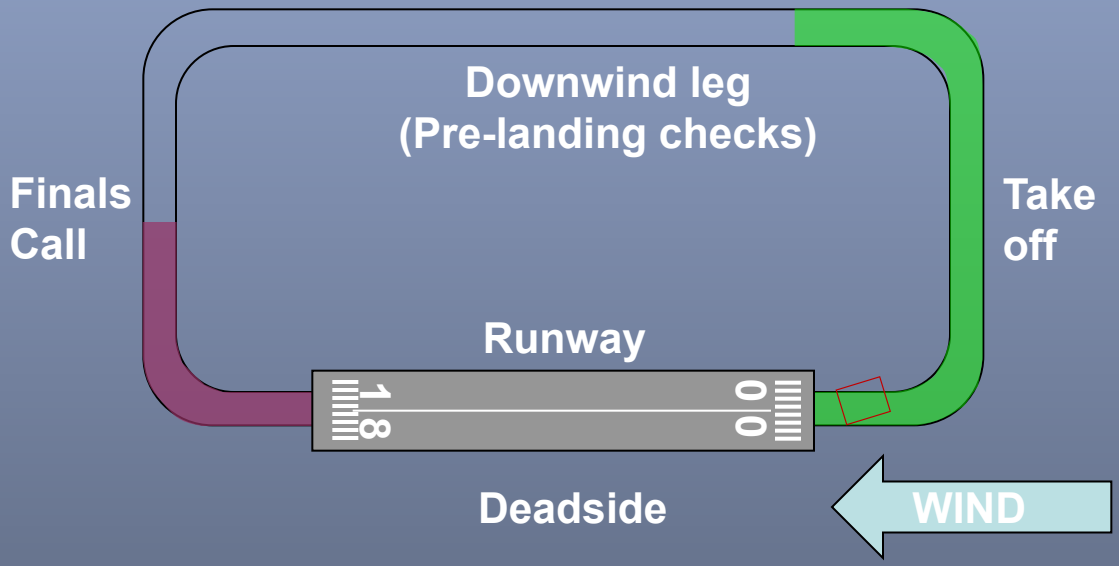

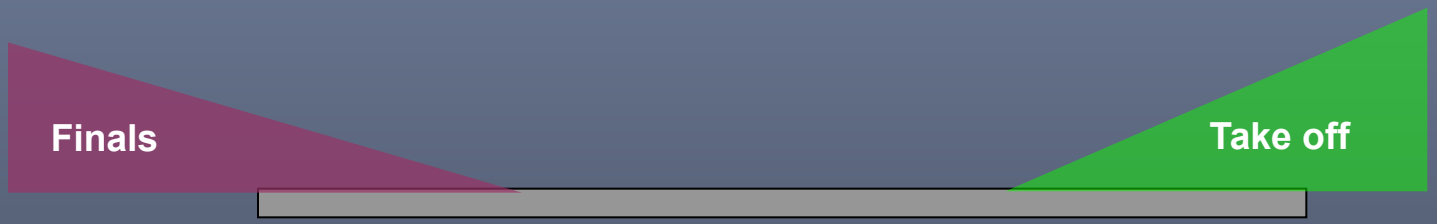

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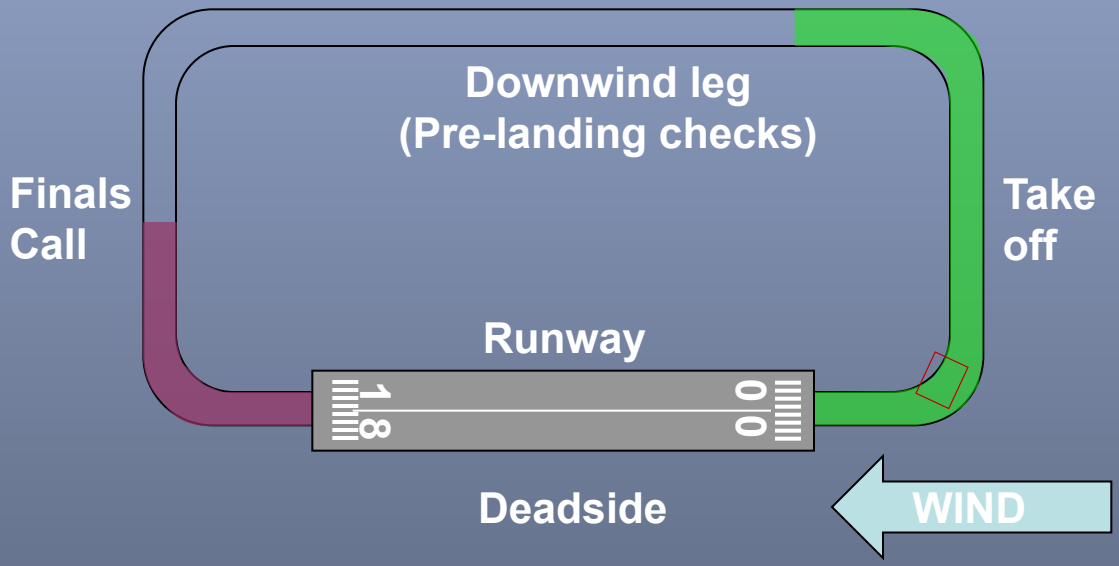

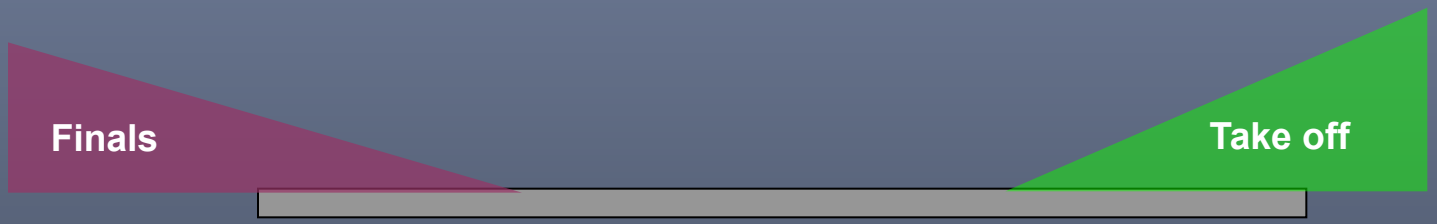

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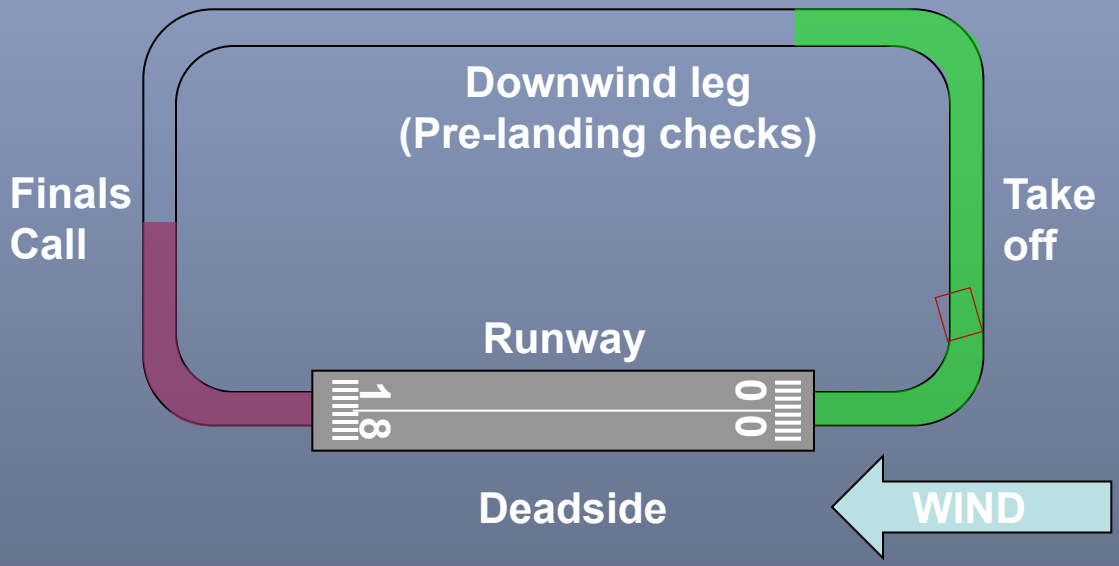

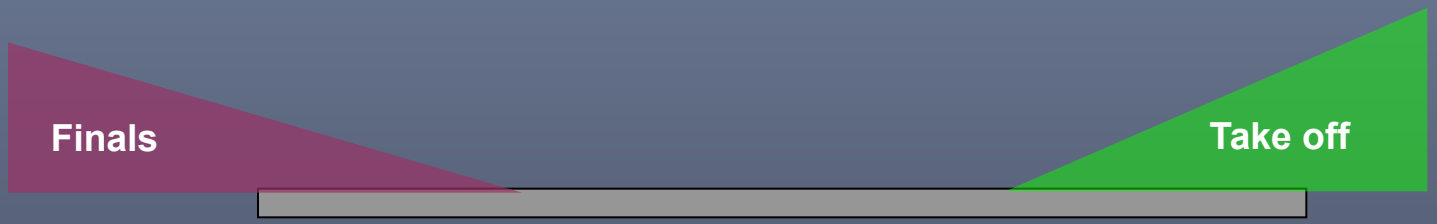

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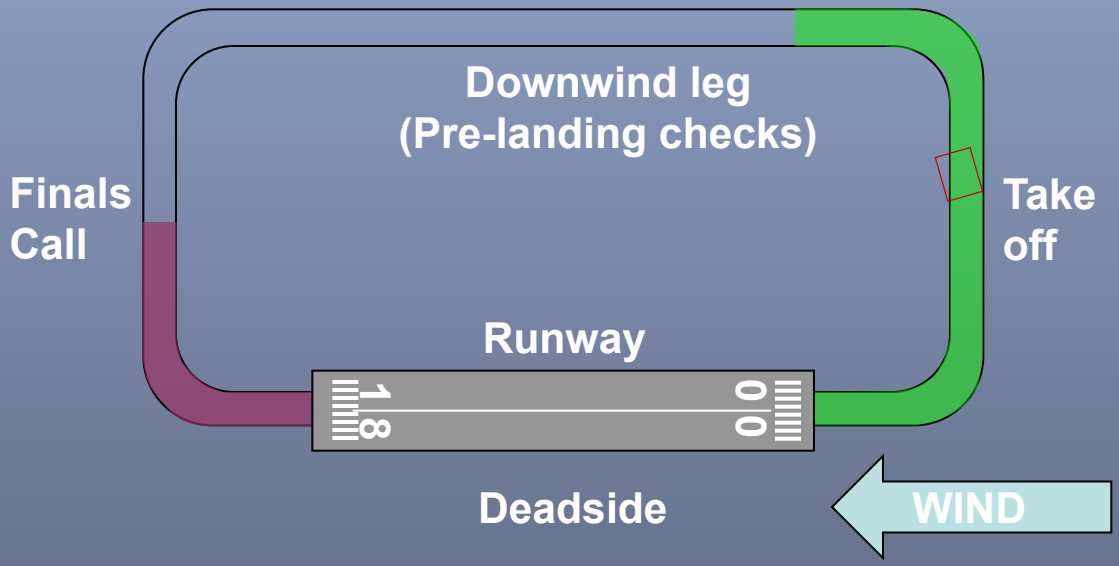

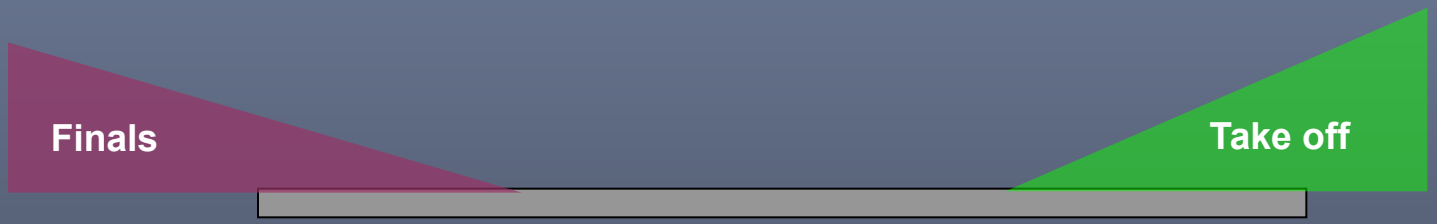

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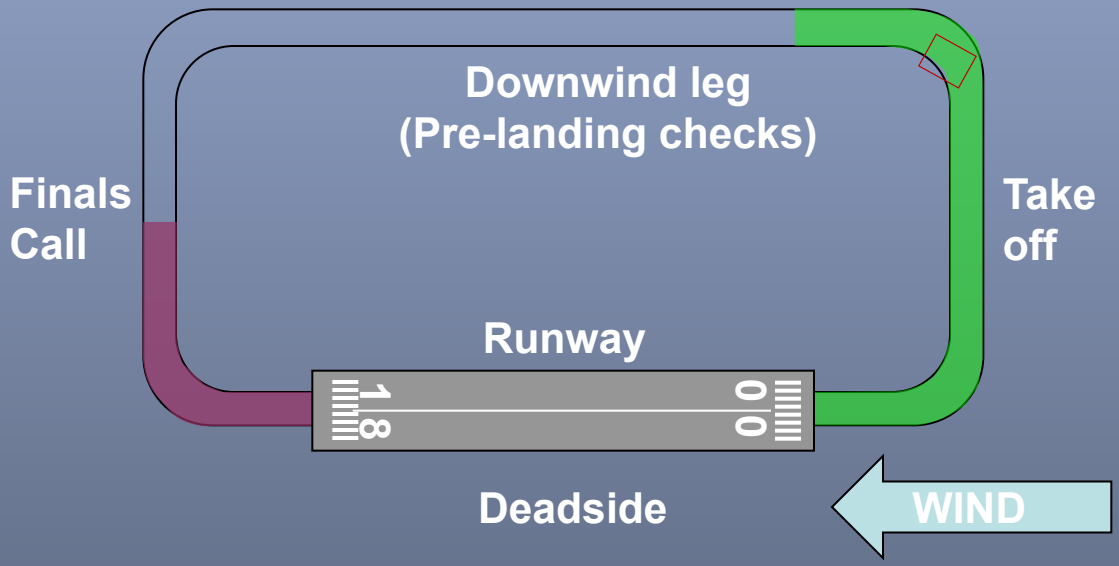

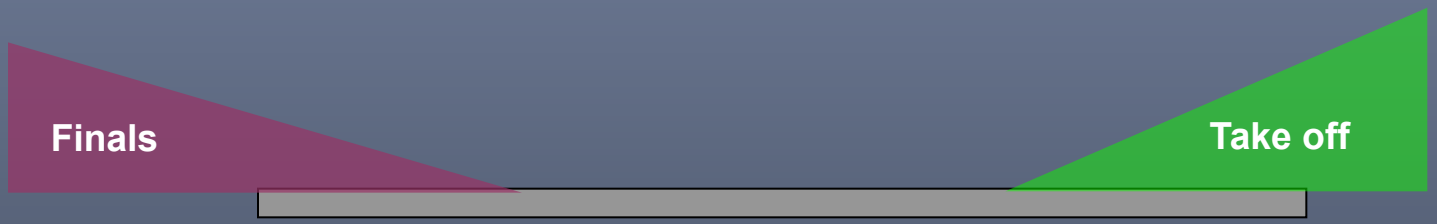

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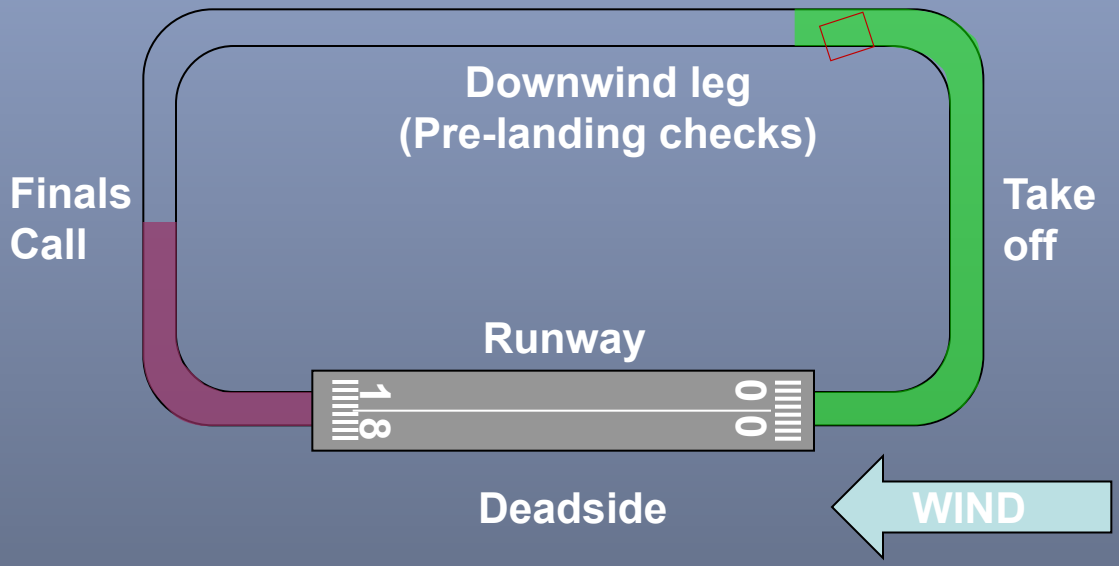

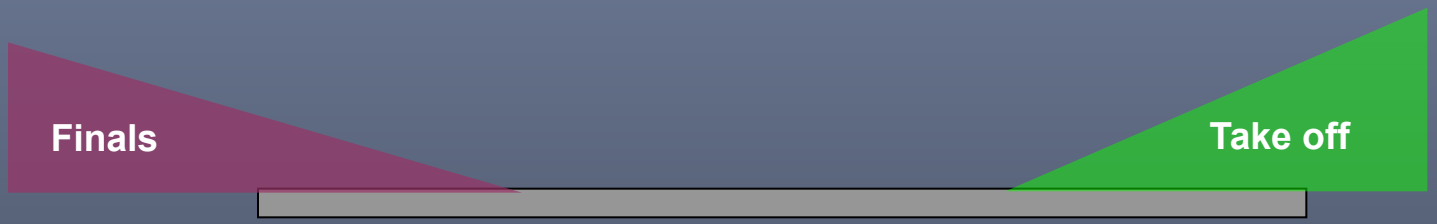

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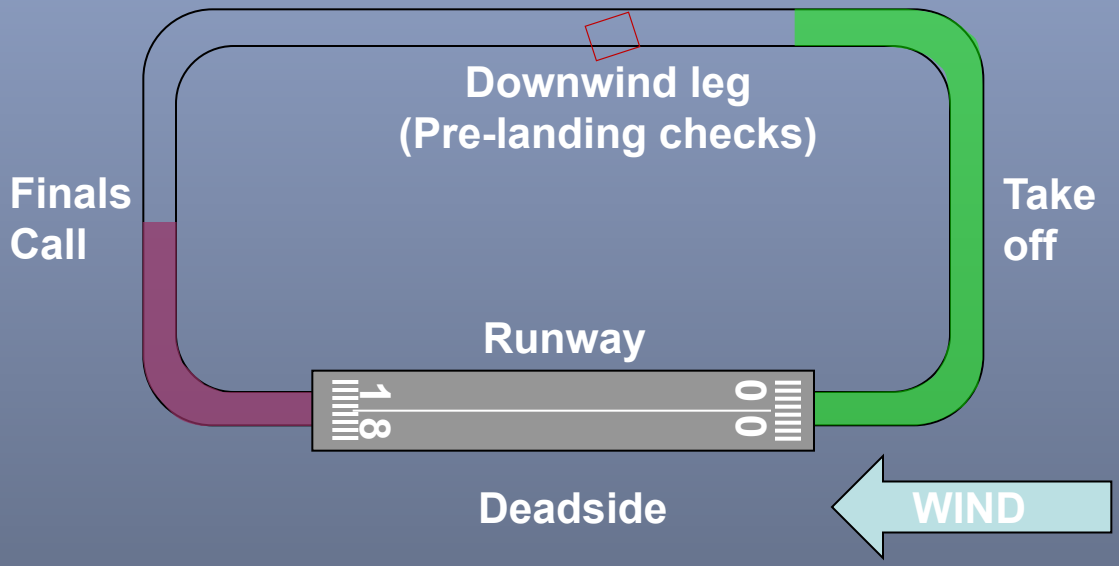

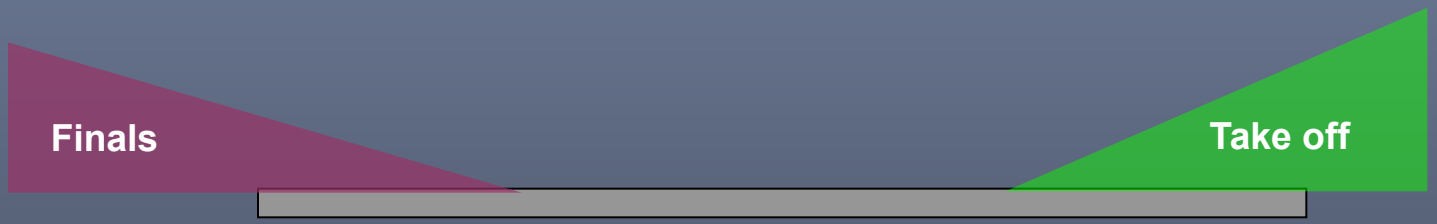

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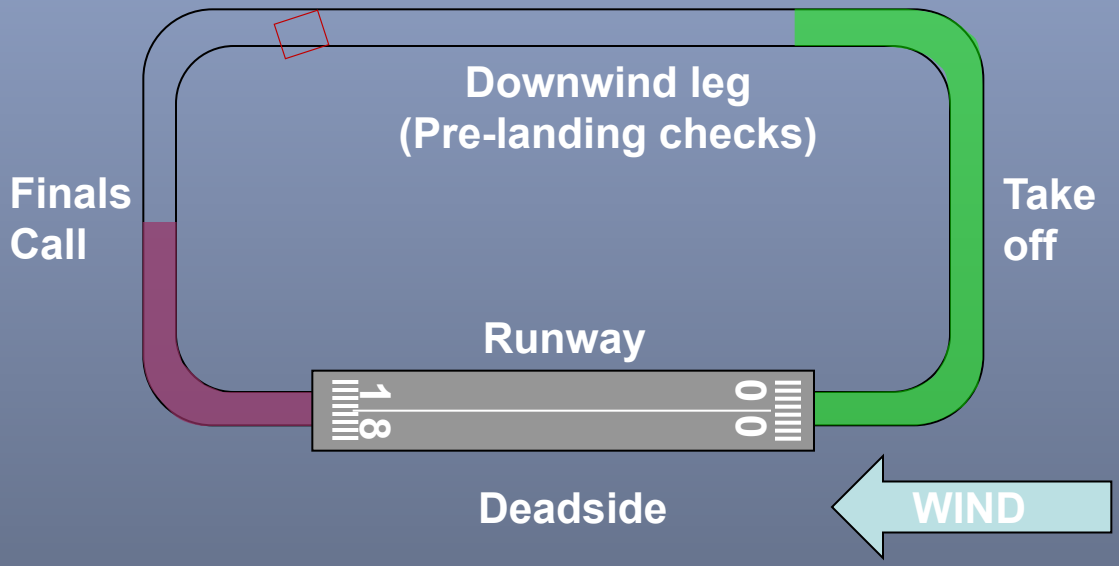

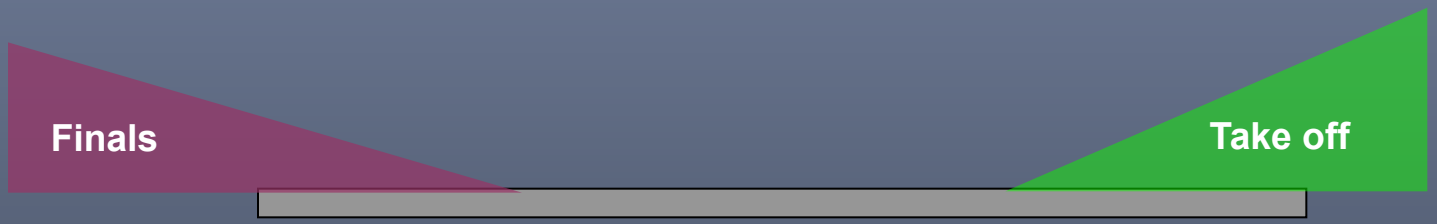

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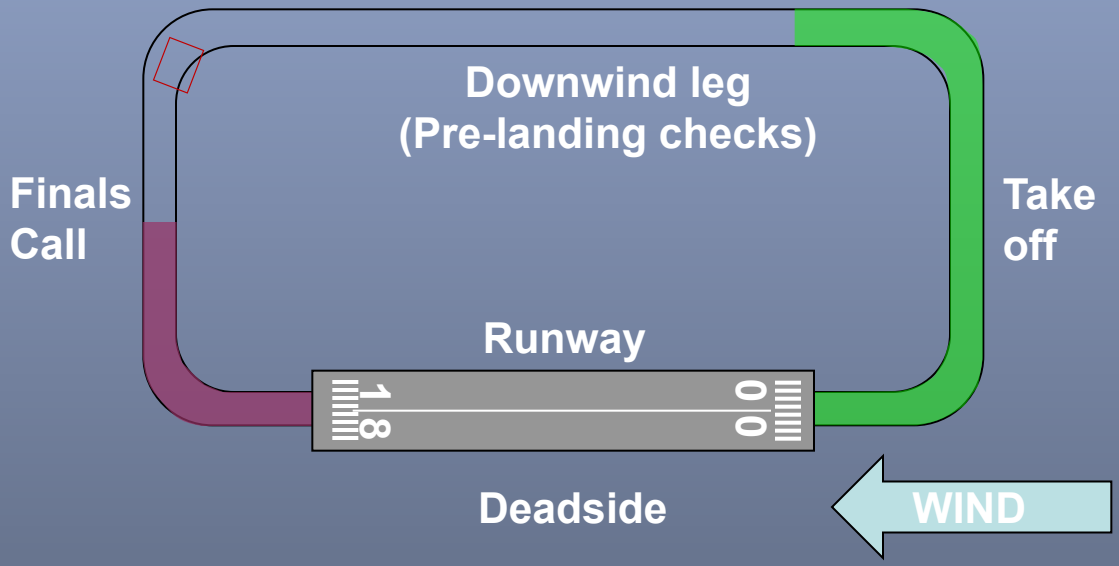

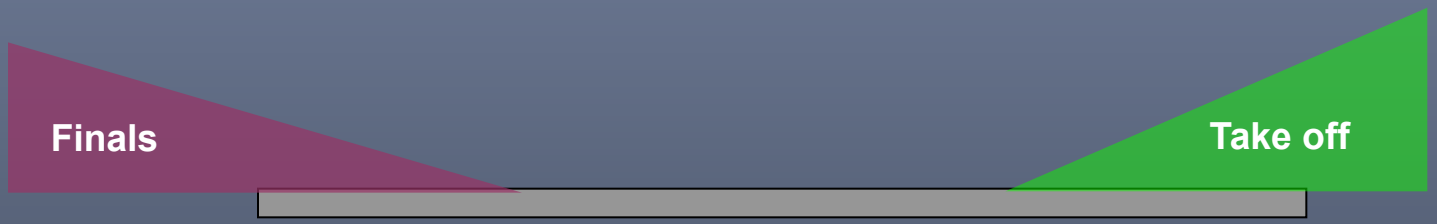

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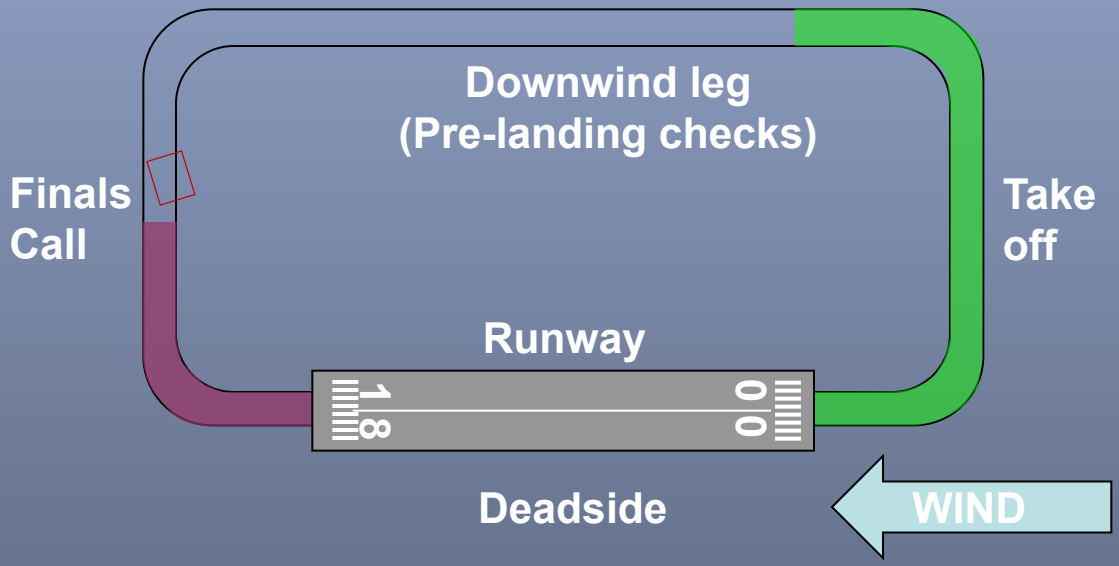

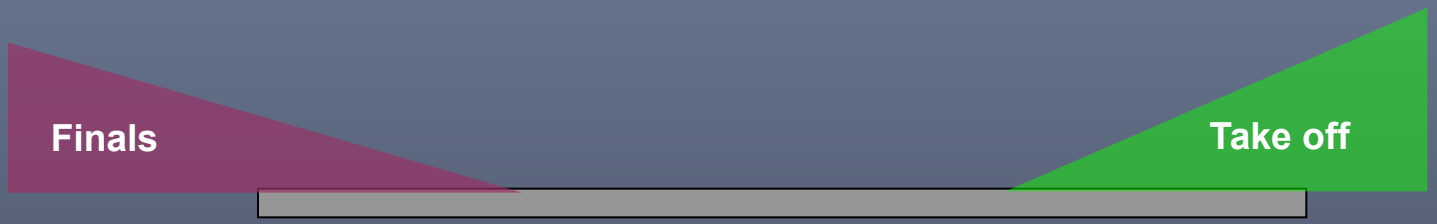

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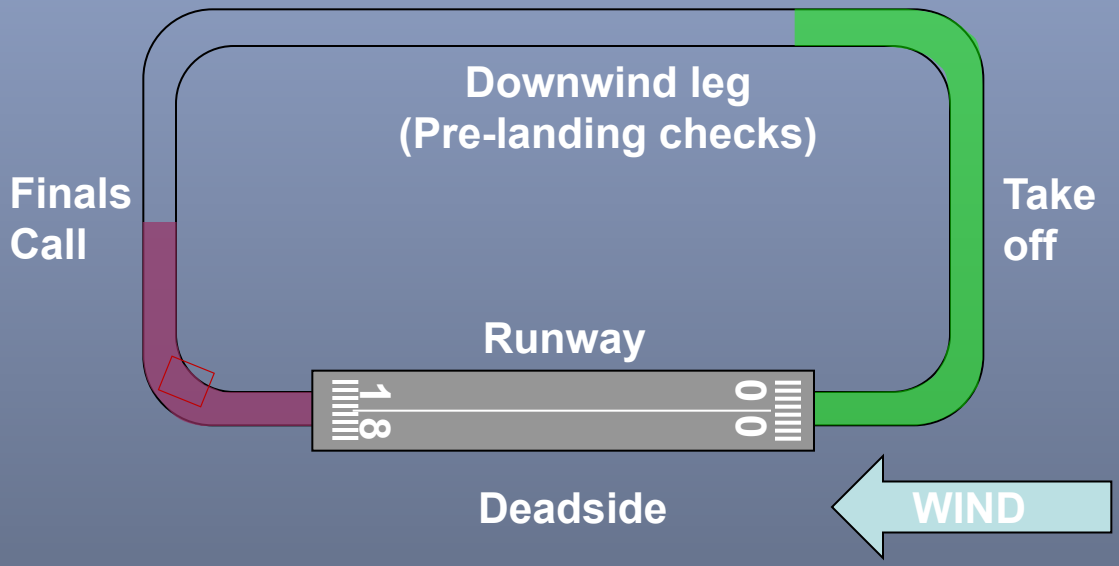

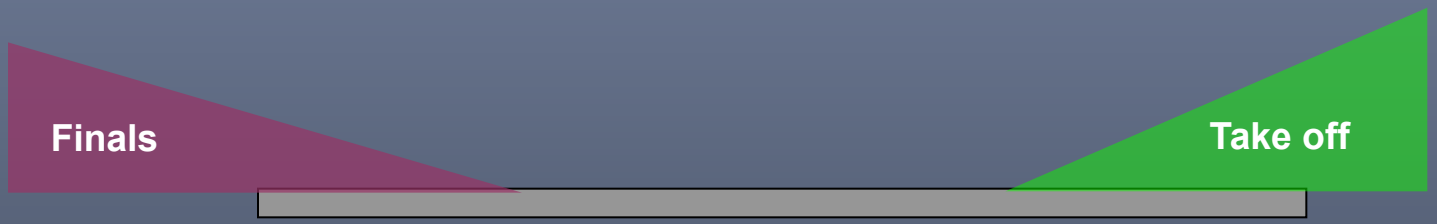

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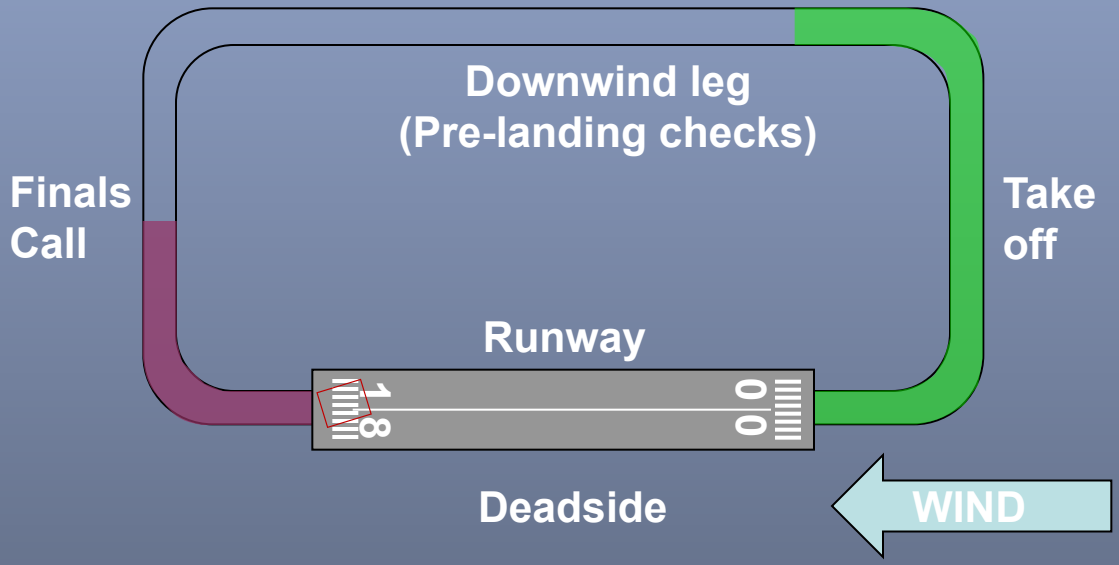

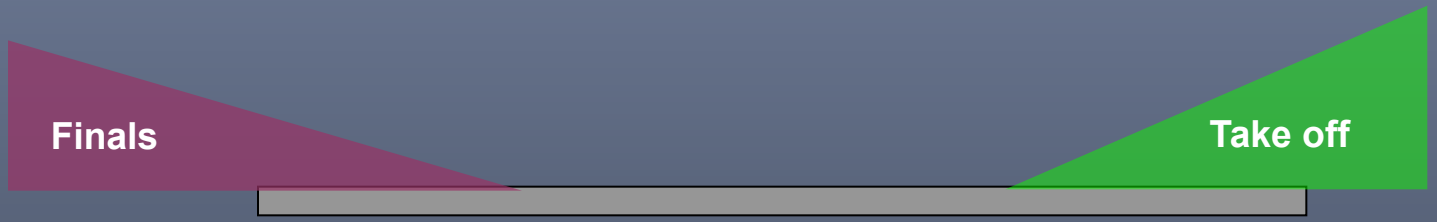

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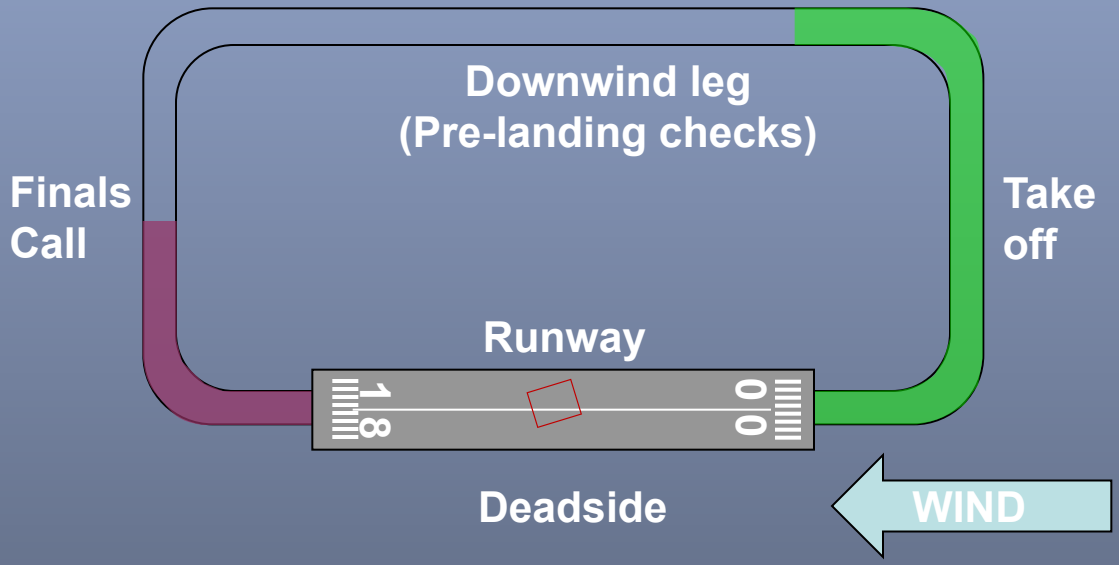

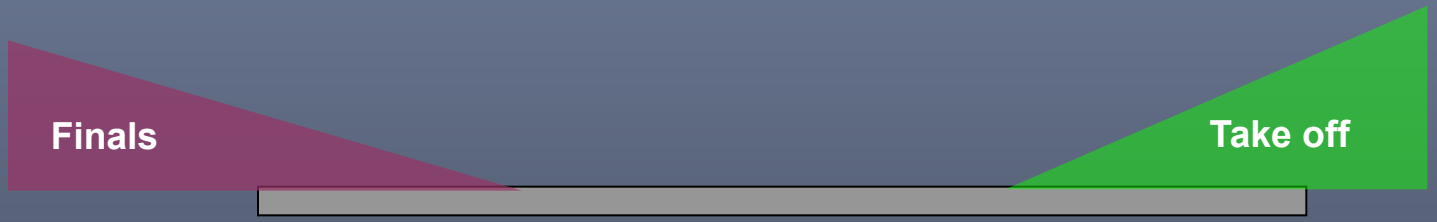

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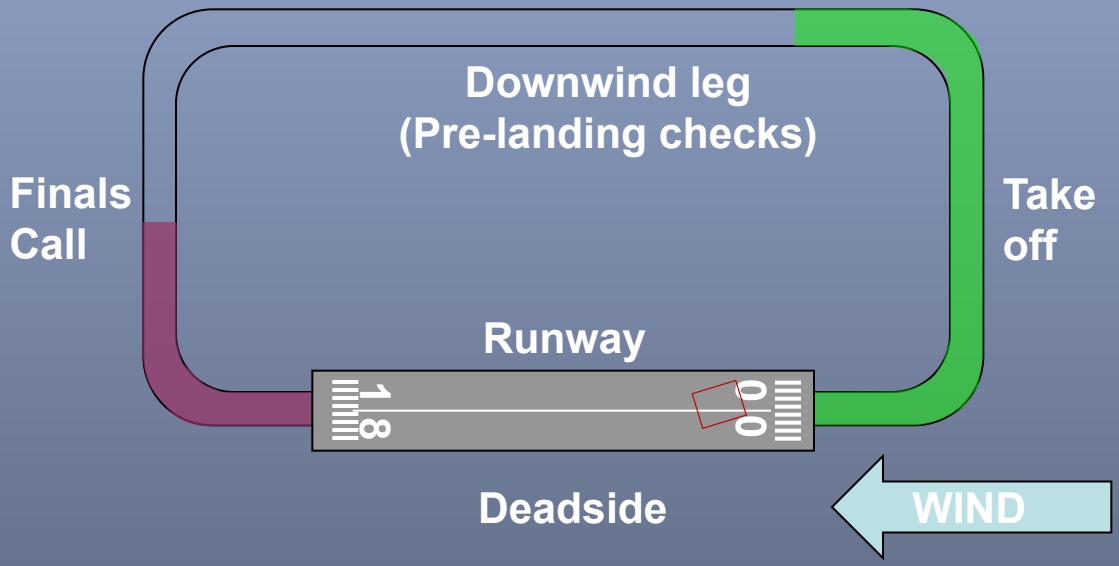

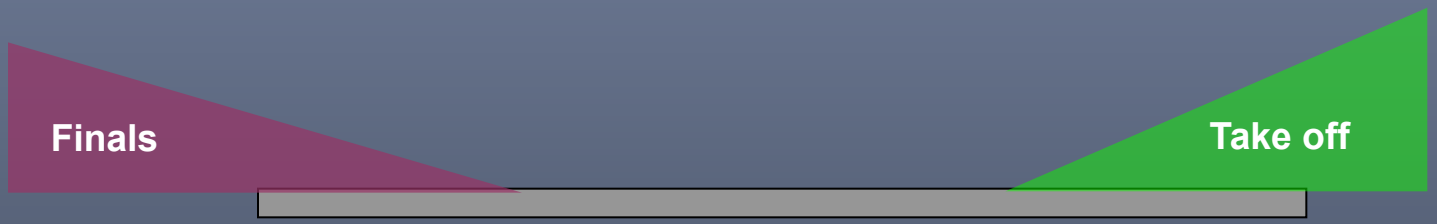

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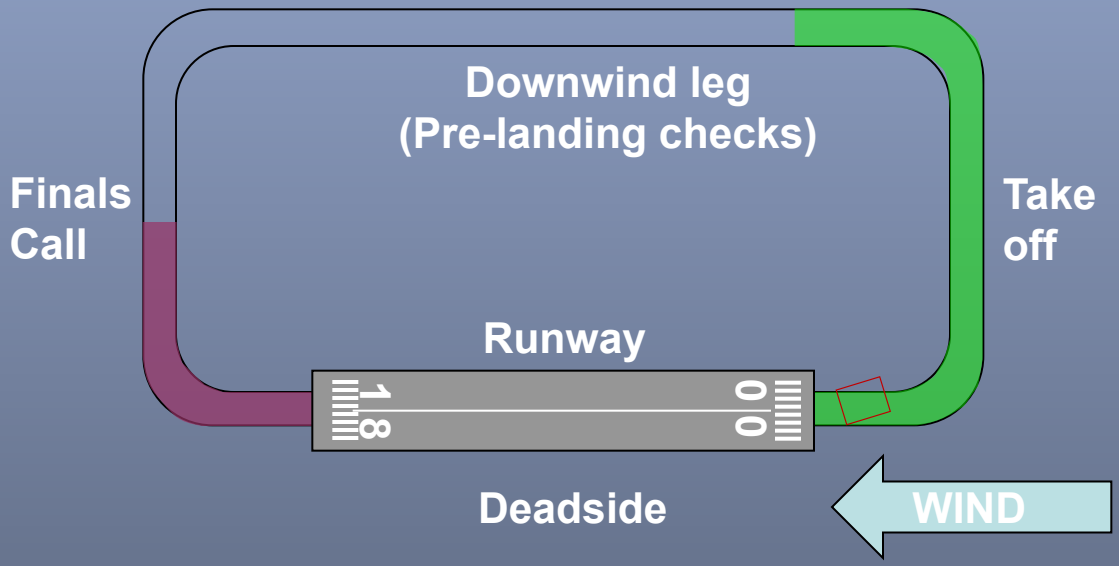

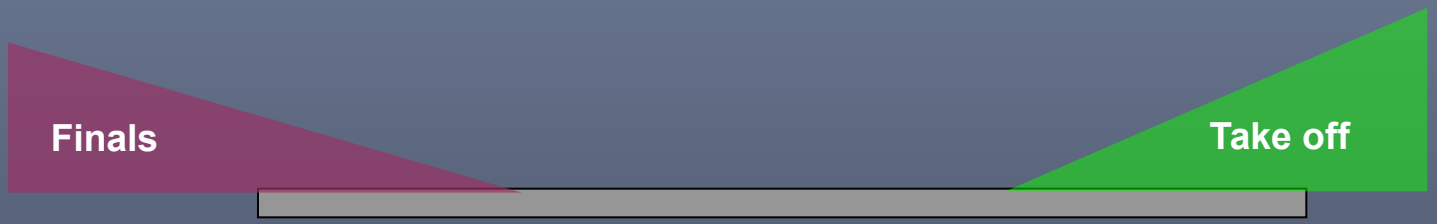

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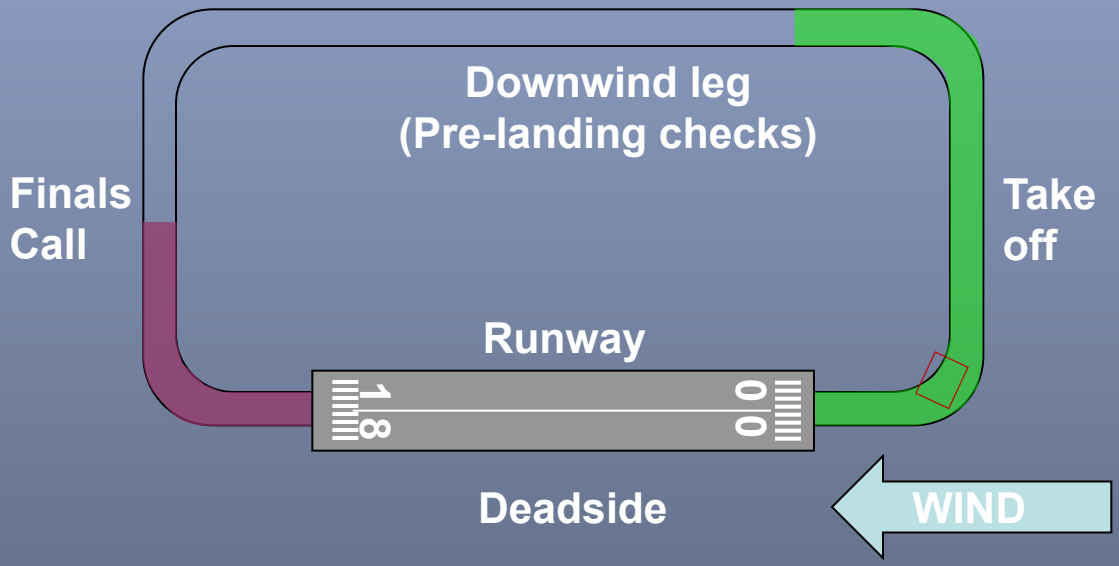

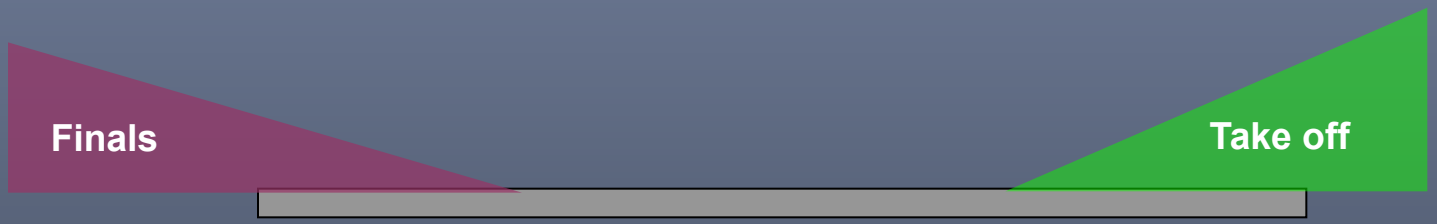

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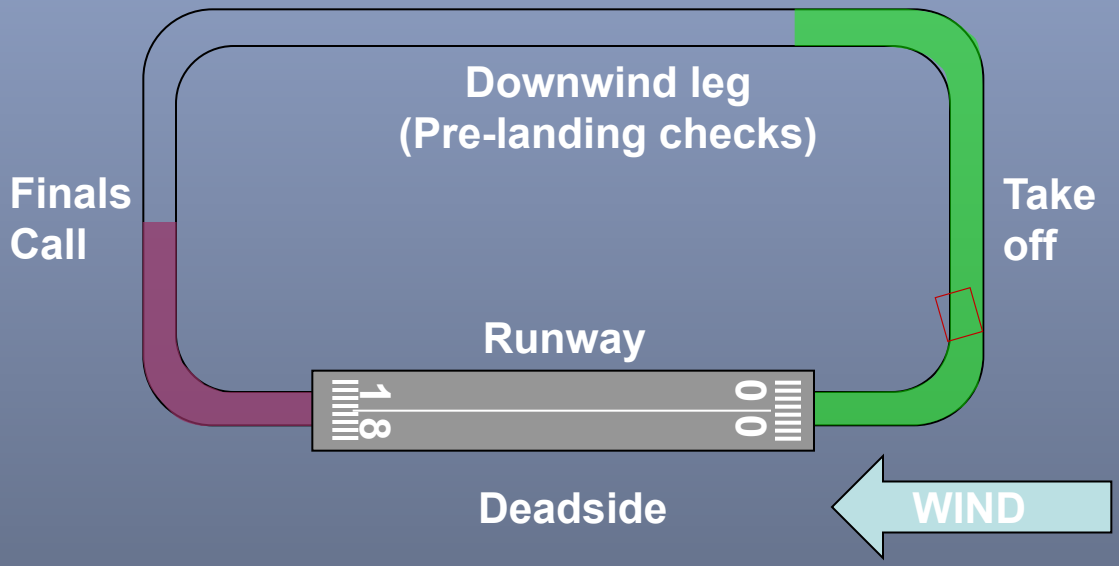

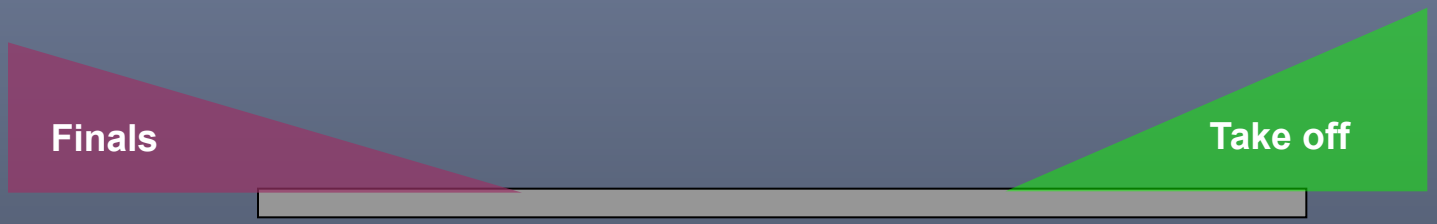

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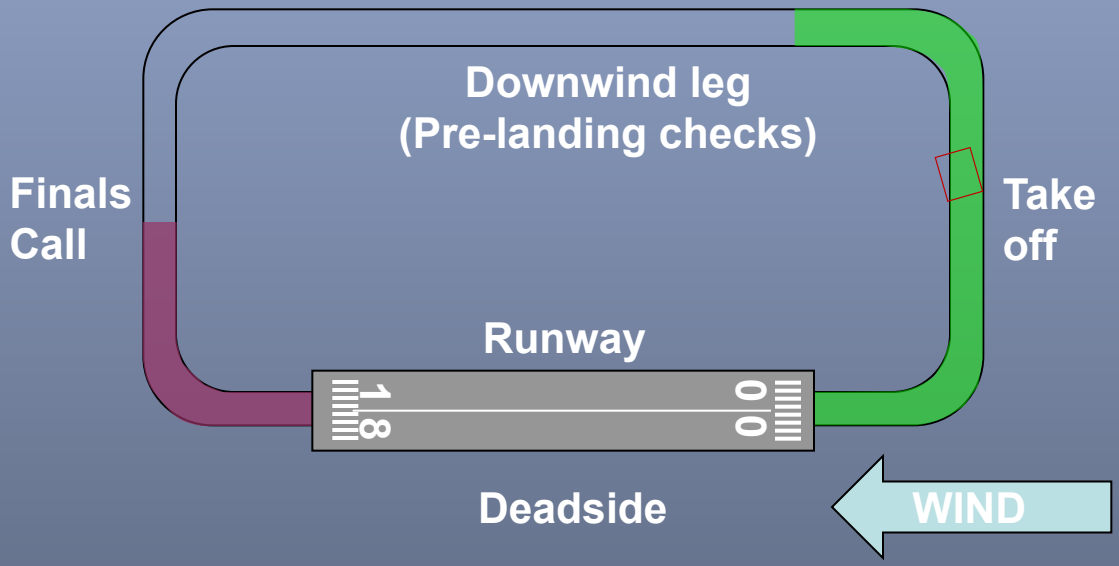

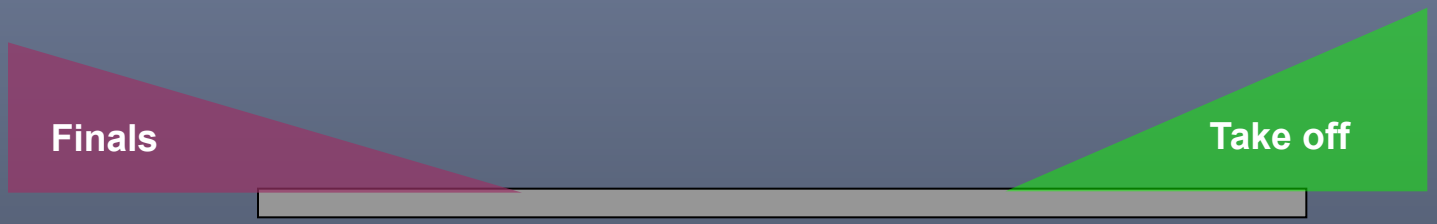

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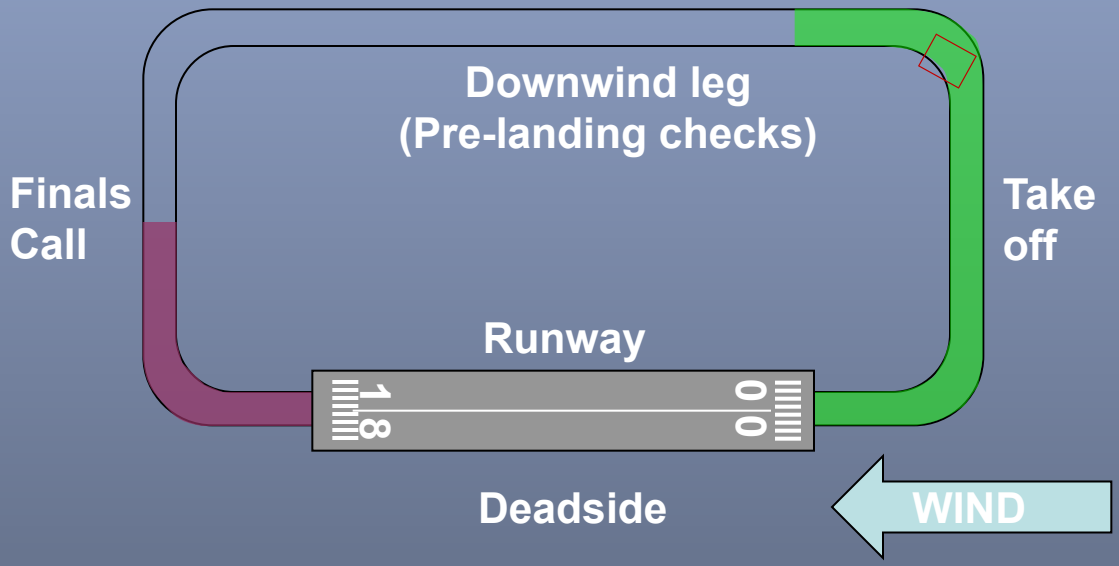

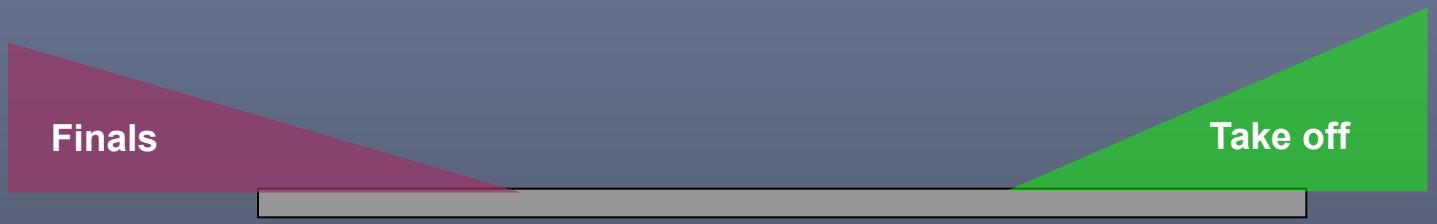

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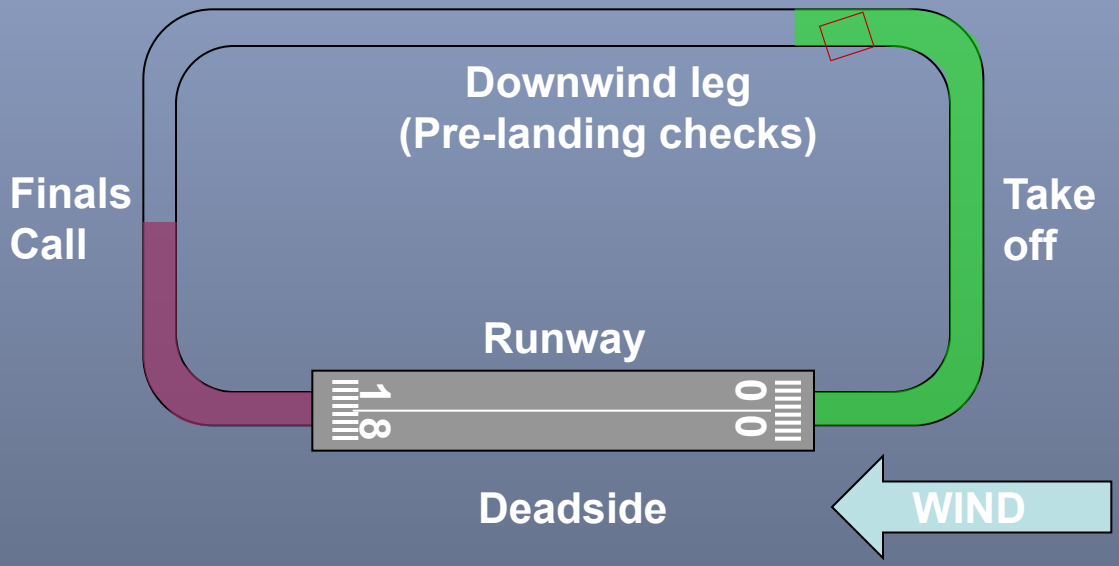

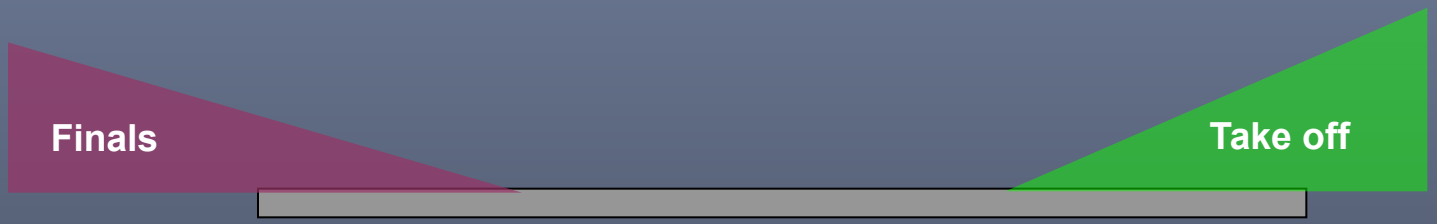

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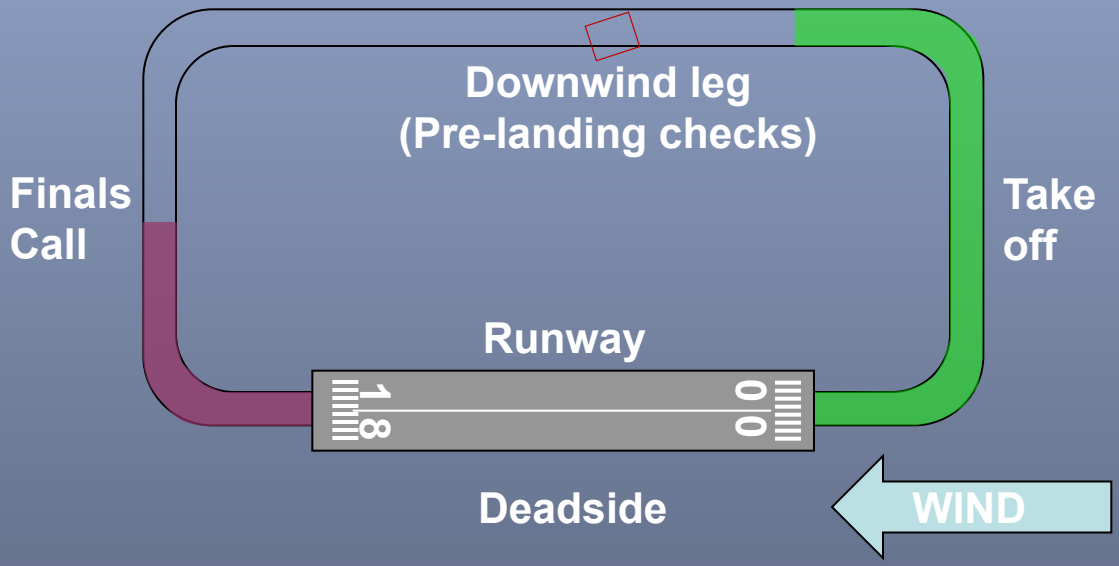

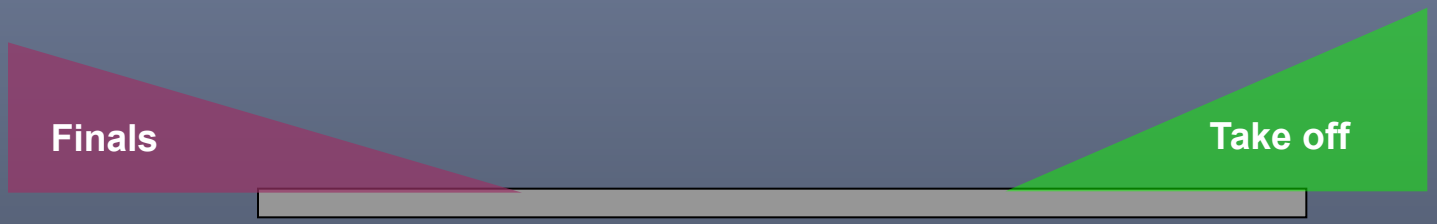

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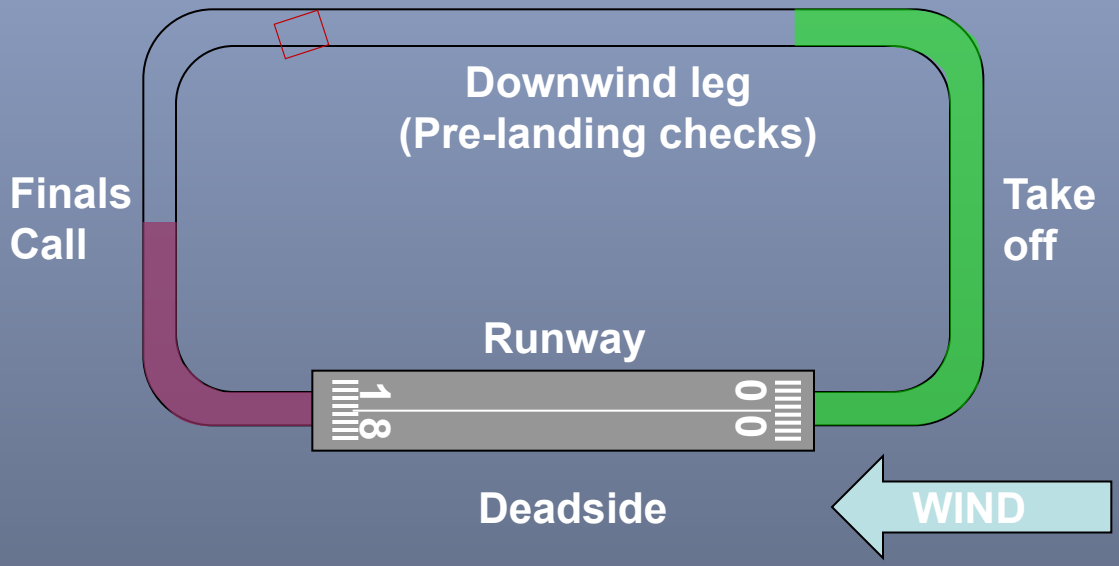
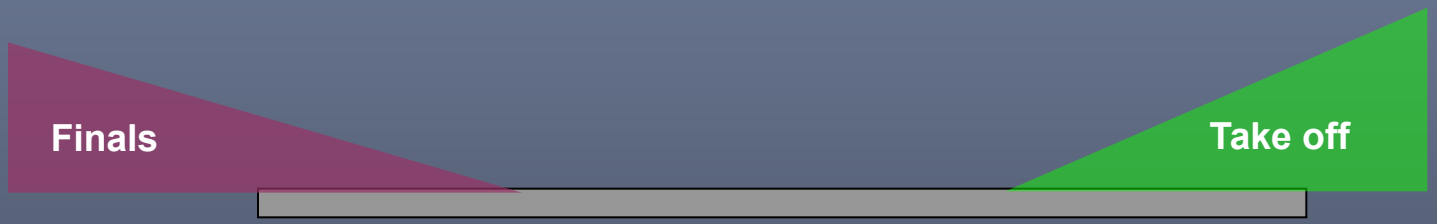
The Circuit





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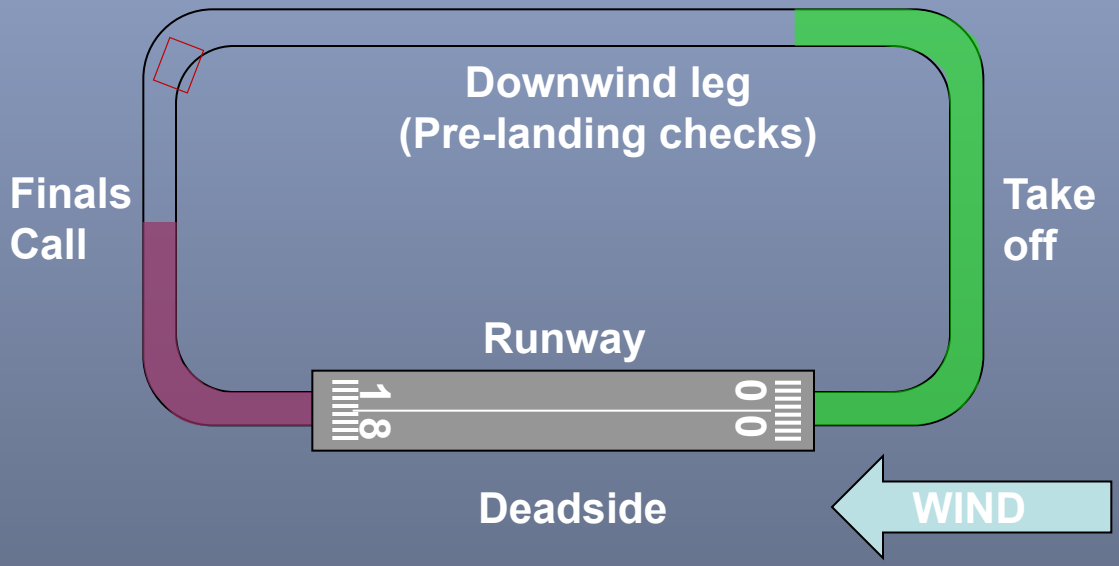

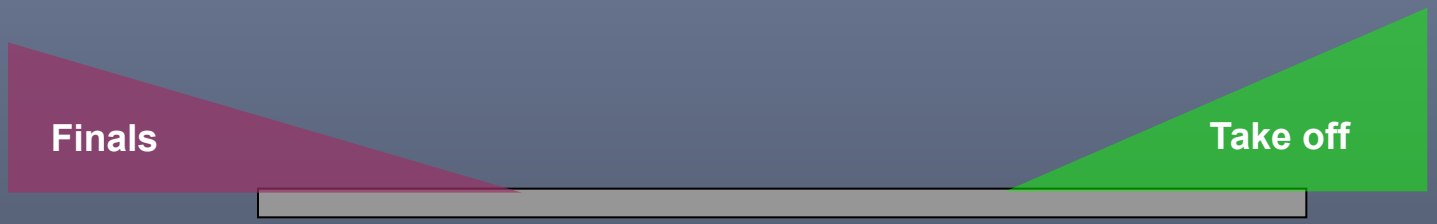

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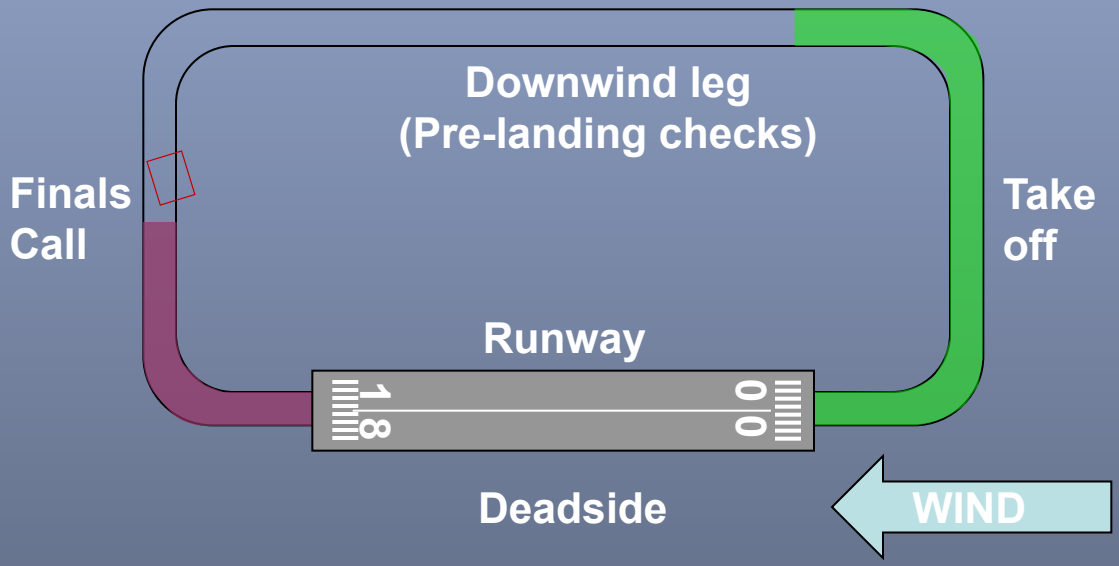

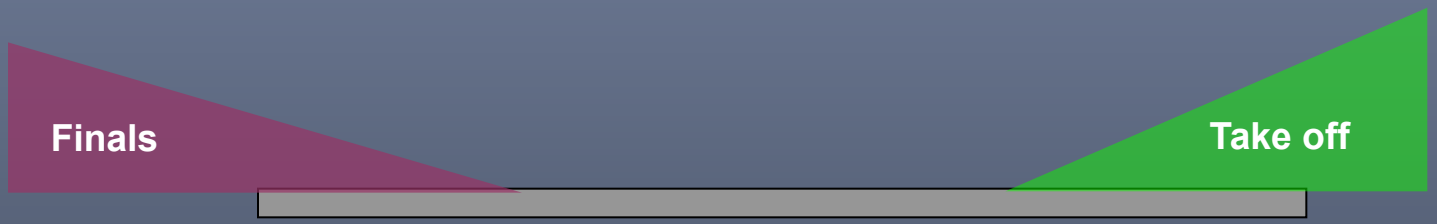

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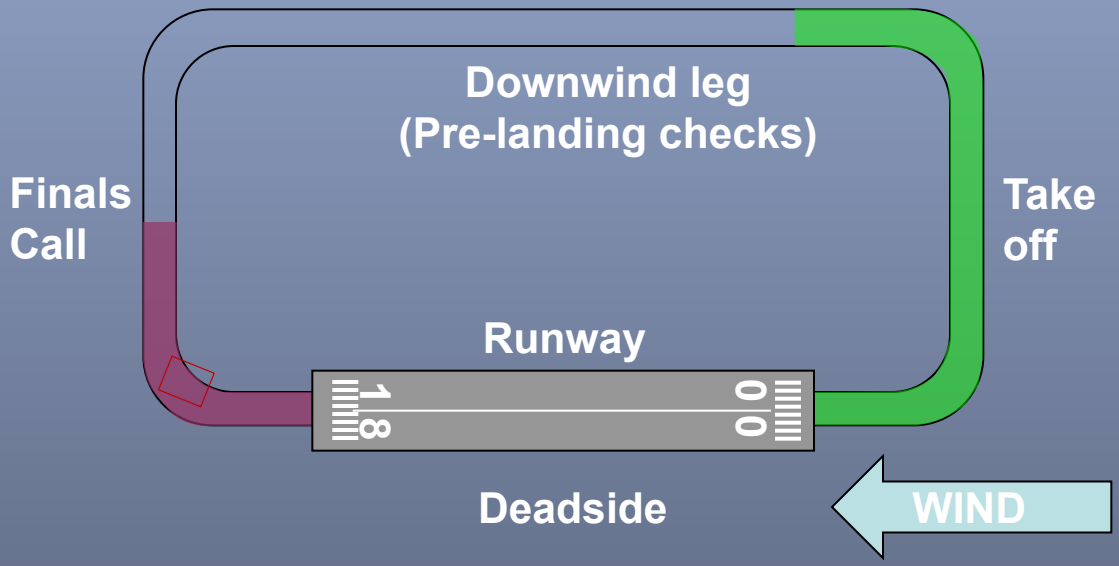

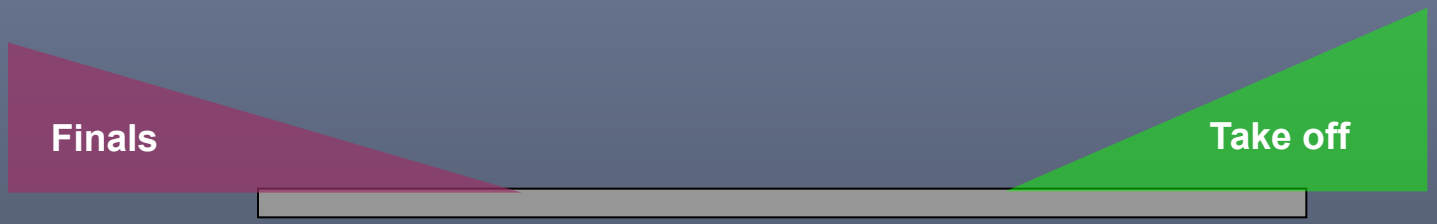

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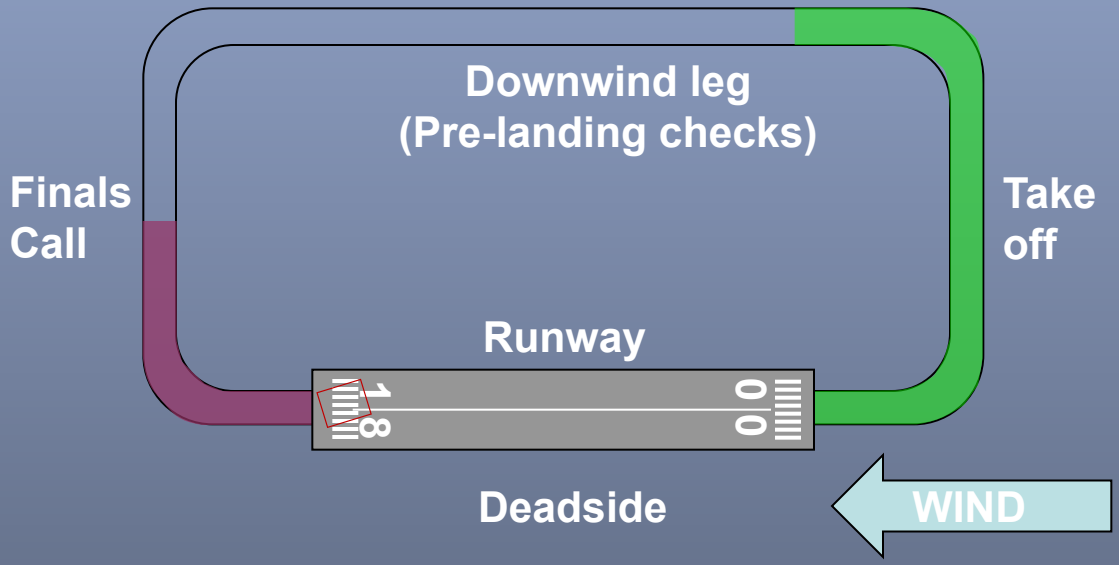

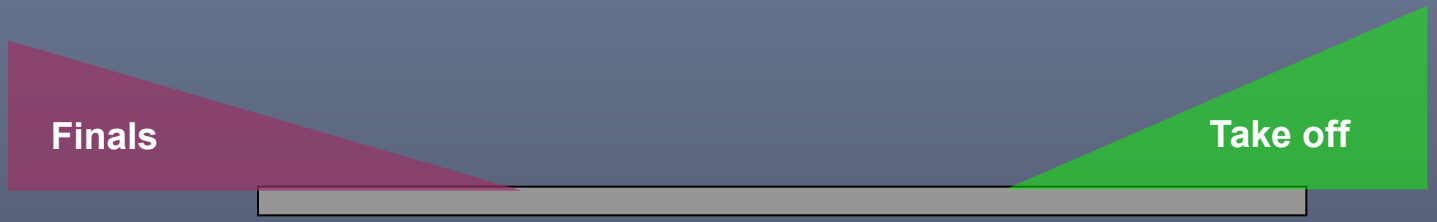

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Joining the Circuit

- Approached airfield whilst maintaining a look-out for other aircraft using, leaving or joining circuit.
- Carry out checks:
  - Fuel - sufficient
  - Instruments - functioning and set
  - Radio - correct frequency selected
  - Altimeter - correct setting
  - Demist and screen heat - as required
  - Induction air - as required
- Receive clearance from airfield controller
- Join overhead at a min of 1000ft above circuit height
- Reduce to circuit joining speed (normally 100 knots) before reaching the airfield boundary.

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Circuit Pattern

Aim

- To reach the downwind leg at circuit height and speed without causing any disturbance to other circuit traffic.

Process

- Turn into the “dead” side in a wide curve, checking airspace underneath
- Fly the downwind leg parallel complete pre-landing & vital actions:
  - RPM control: max, Mixture: fully rich, Induction air: cold, Fuel: booster pump on, contents sufficient, selector valve as require, Flap: as required, Harness: tight
- Gradual turn onto the final approach when a suitable position is reached the
- Adjust the turn so that at the end of it the aircraft is lined up with the runway.
- Makes the “Finals” call to the controller during the turn.

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The Approach

Good approach = Good landing

- Flaps give the pilot:
  - A steeper path of descent at a given speed.
  - A lower stalling speed, a low IAS without reducing the safety margin.
  - A better view over the nose & runway
- The amount of flap depends on the aircraft, wind speed & direction.
- Partial flap is often used in the early stages of the approach.

Windage

- Landing into wind enable:
  - Reduced ground speed to a minimum for a given airspeed.
  - Drift is eliminated.
  - Shortened landing
  - Decreased undercarriage side load
  - Less tendency to swing
- Also, if required, the aircraft can circuit again and regain altit. rapidly.
- Strong winds decrease windspeed close to the ground due to friction – this leads to sudden reduction in IAS, a rapid sink and a heavy landing.

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Landing

- **Final Approach**: starts when aircraft is alligned with runway
- **Roundout**: aircraft attitude is changed from descent into a tail down attitude
- **Hold-off/float**: flying parallel to ground with decreasing increasing angle of attack and falling IAS
- **Touch down**:
  - Tail dragger – 3 point (all 3 wheels together) or main first
  - Nose wheel – ALWAYS main wheels first (prevent nose wheel damage)

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Landing – Process

- Nose wheel aircraft:
  - Aircraft approaches threshold, throttle back, nose up
  - Aircraft sinks onto main wheels
  - If floating occurs, nose is gently lowered to avoid ballooning nose wheel
  - Apply brakes as necessary
- Tail wheel aircraft:
  - Aircraft approaches threshold, round out, throttle back
  - Aircraft sinks onto all wheels at the same time
  - Use stick smoothly to avoid bounce
  - *Alternatively*, main wheels first, as G/S drops tail will fall
- Cross wing approach
  - To avoid drift in cross wind, pilot aligns with centre line, with nose pointing into crosswind
  - Before touchdown, pilot yaws to straighten aircraft

Shortening Landing

- **Aerobraking**: slowing aircraft by using the airframe (Typhoon nose wheel failure, 2006)
- **Airbrakes**: decreases airspeed on finals
- **Brakes**: apply brakes early to reduce length – ensure nose/tail is held down to achieve max affect
- **Reverse thrust**: thrust is transferred from forward to reverse, so rapid deceleration
- **Parachute**: deploy parachute to brake groundspeed
- **Flaps**: Deploying flaps decreases touchdown speed and increases drag

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Aerobatics and Formation Flying

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Recap

- Aircraft Maintenance
- Ground Handling
- Prep for Flight
- General Flying
- *Aero's & Formation flying*

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Aero's History & Modern

- **History**
  - Used by pilots to manoeuvre into a favourable firing position, or to avoid the guns of enemy aircraft.
- **Modern**
  - Give the pilot confidence in handling aircraft
  - Experience at operating in different attitudes
  - Accustom pilot to the high strains & stress of combat flying

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HASELL

- **H**eight – sufficient altitude to complete manoeuvre.
- **A**irframe – Flaps and U/C ***UP***, Airbrakes ***IN***.
- **S**ecurity – Equipment and loose articles stowed & seat harness locked and tight.
- **E**ngine – Temperatures, pressures & fuel sufficient.
- **L**ocation – clear of:
  - ***A**ctive* airfields,
  - ***B**uilt-up areas*
  - ***C**ontrolled airspace*.
- **L**ook-Out – keep clear of other aircraft & cloud

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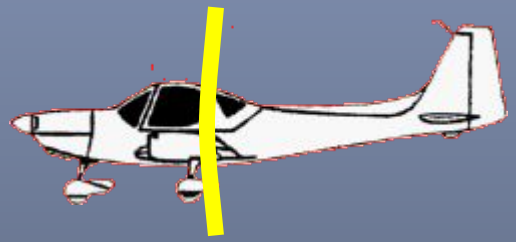
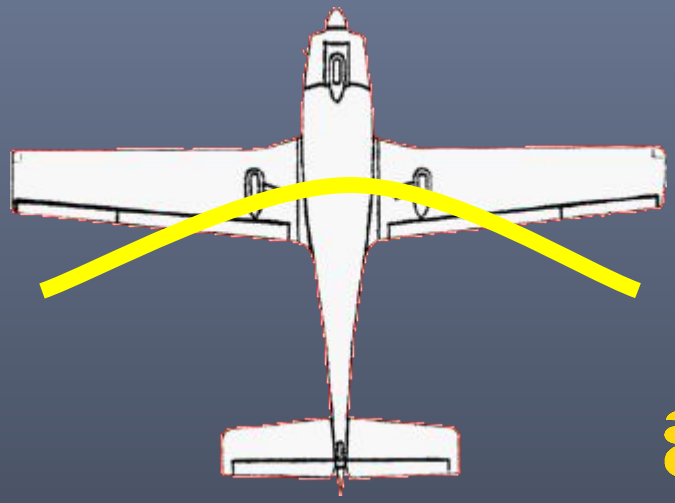
Axis

- All aircraft move in three axis
  - Yaw, Pitch & Roll





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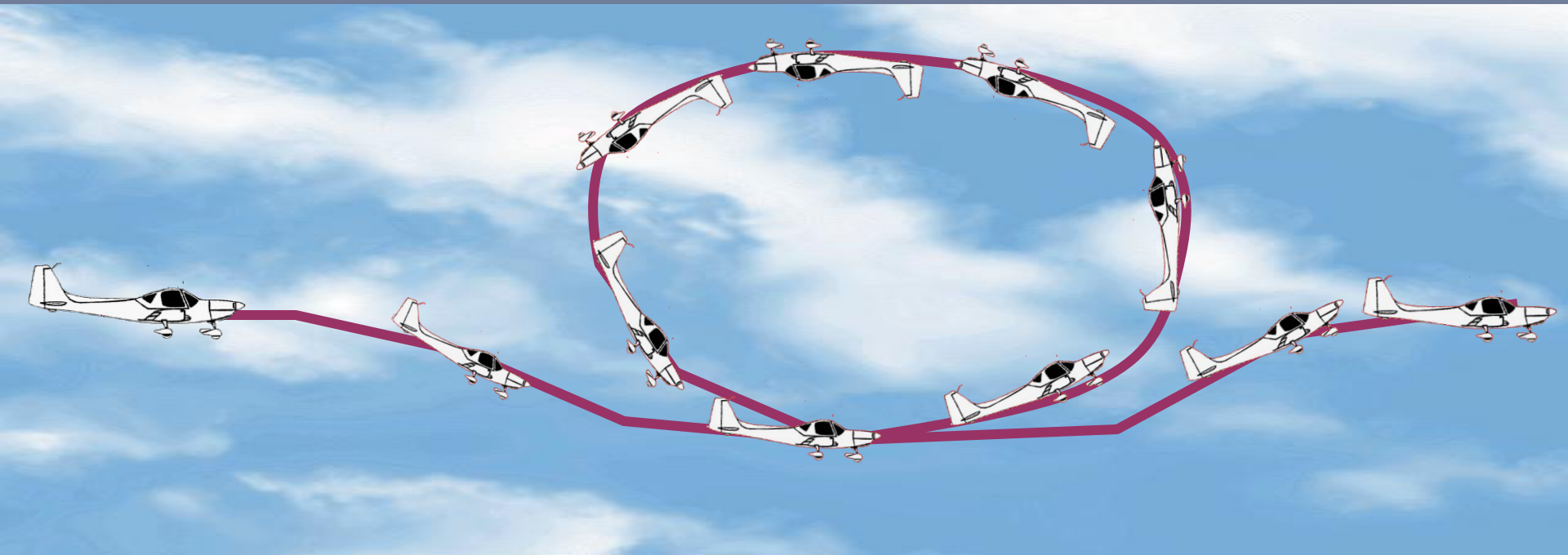
Basic: the loop

- Process
  - Pilot aligns aircraft with linear feature – road, rail
  - Drop nose to increase speed
  - Keep wings level
  - Pull up until horizon disappears, looking overhead for new horizon



Basic: Barrel Roll

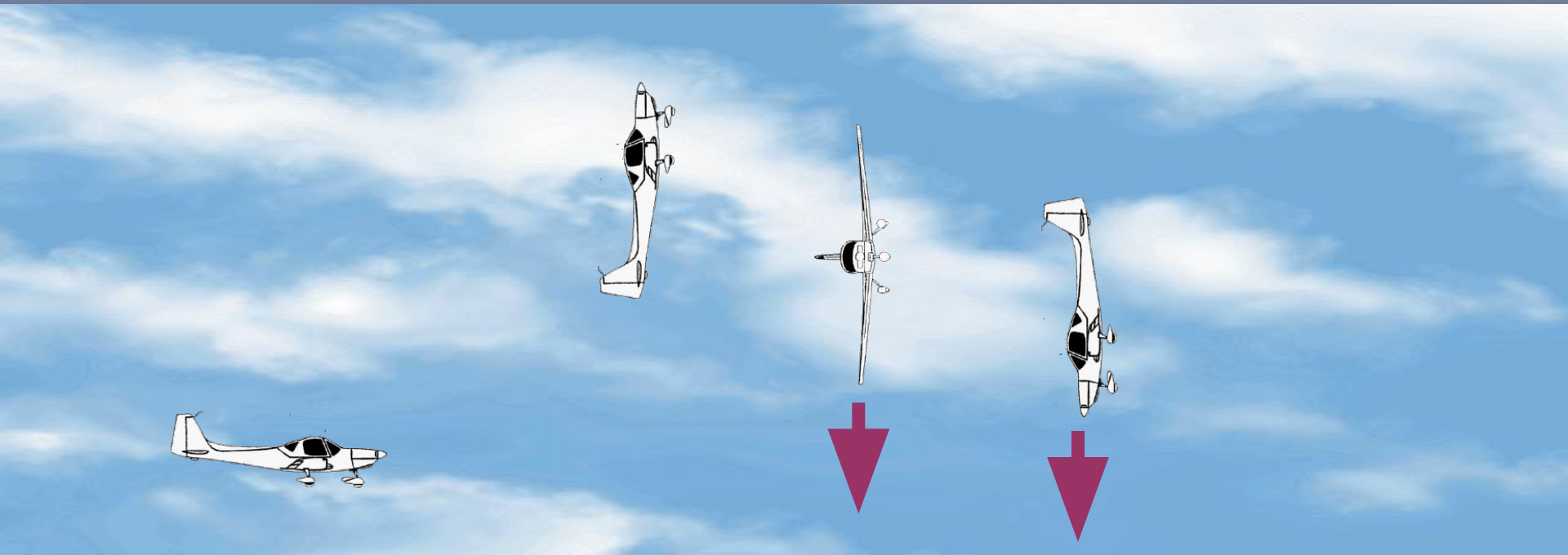
- Process
  - Drop nose to increase speed
  - Pick point above horizon (cloud)
  - Roll 45° away from banking direction
  - Roll in banking direction, with nose of aircraft pointing at point on horizon

Basic: Slow Roll

- Process
  - As barrel roll, but slower
  - Pilot must keep nose on horizon
  - Smooth and gentle of controls
  - Steady and slow roll

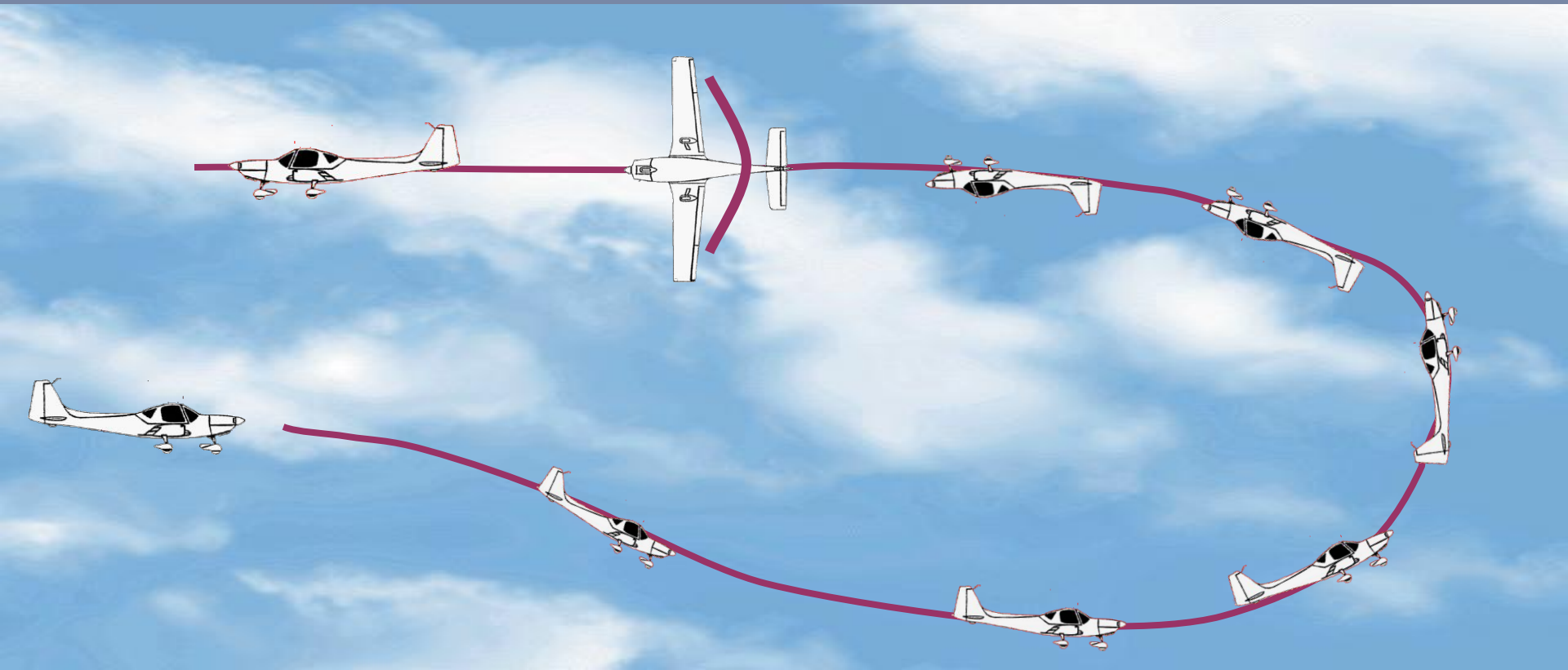
Basic: Stall turn

- Only manoeuvre in yawing axis
- Process
  - Nose up to 90° from horizontal, decreasing speed
  - Before wing stalls (zero lift, zero speed) apply rudder
  - Aircraft falls sideways until nose is pointing down
  - Speed increases, round out at the bottom



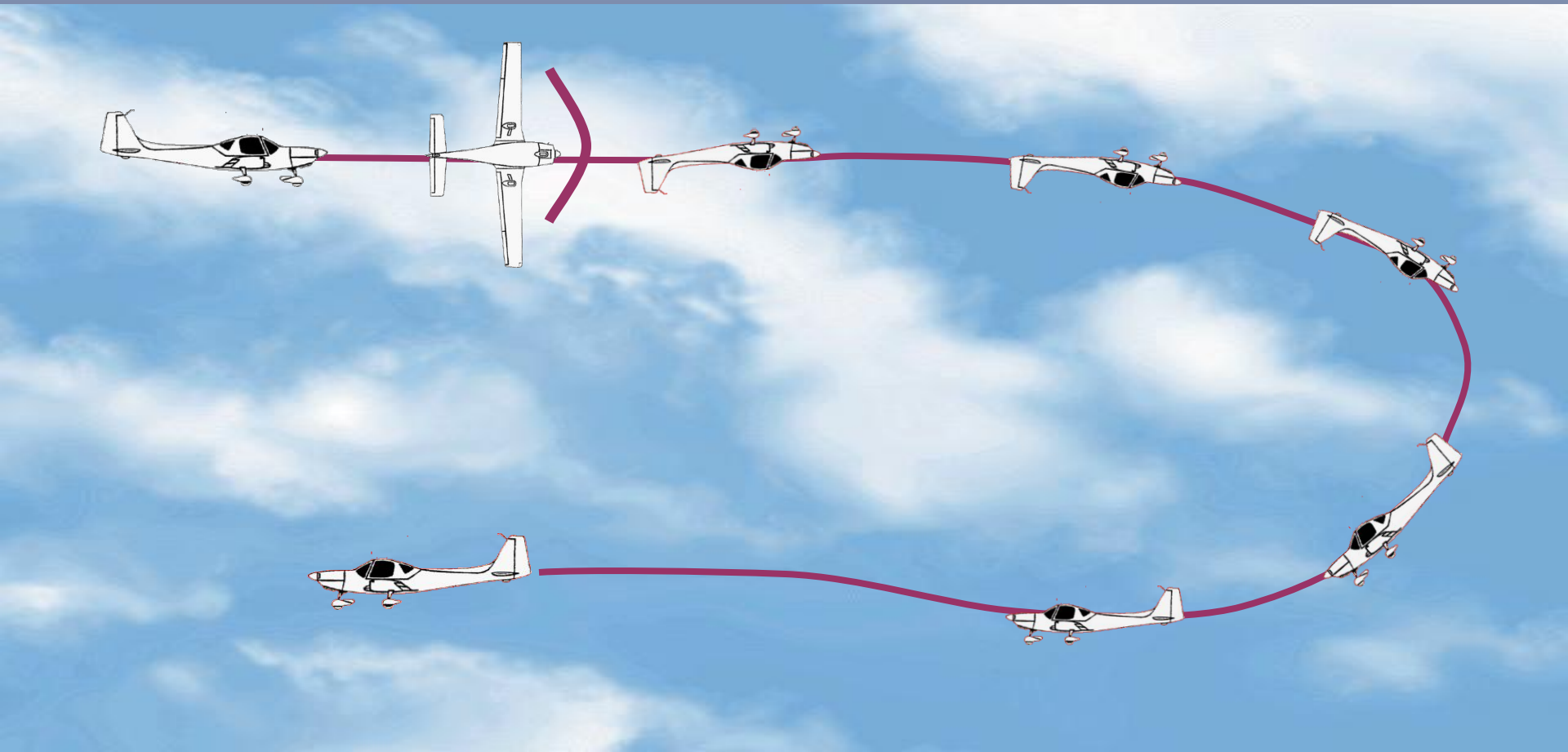
Advanced: Roll of the top

- Process
  - ½ Loop followed by Barrel or Slow roll at top



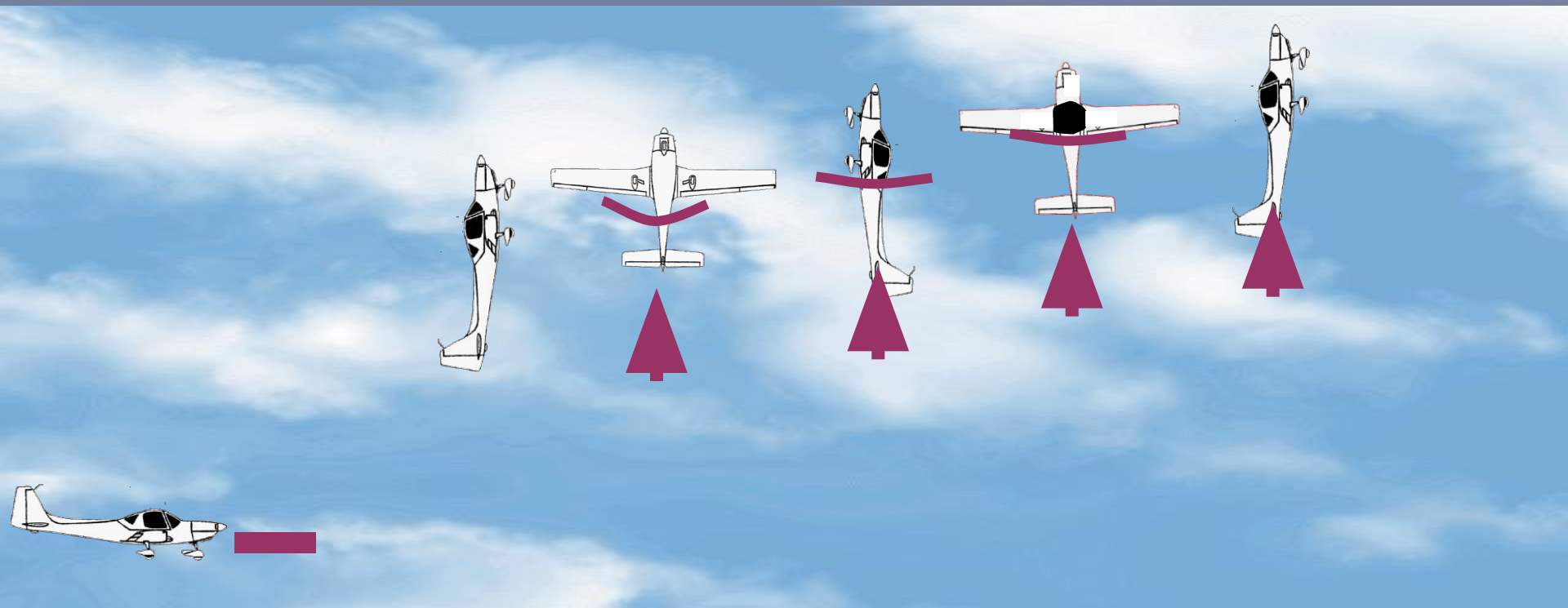
Advanced: Half roll & pull through

- Process
  - Barrel or Slow roll followed by second half of ½ Loop



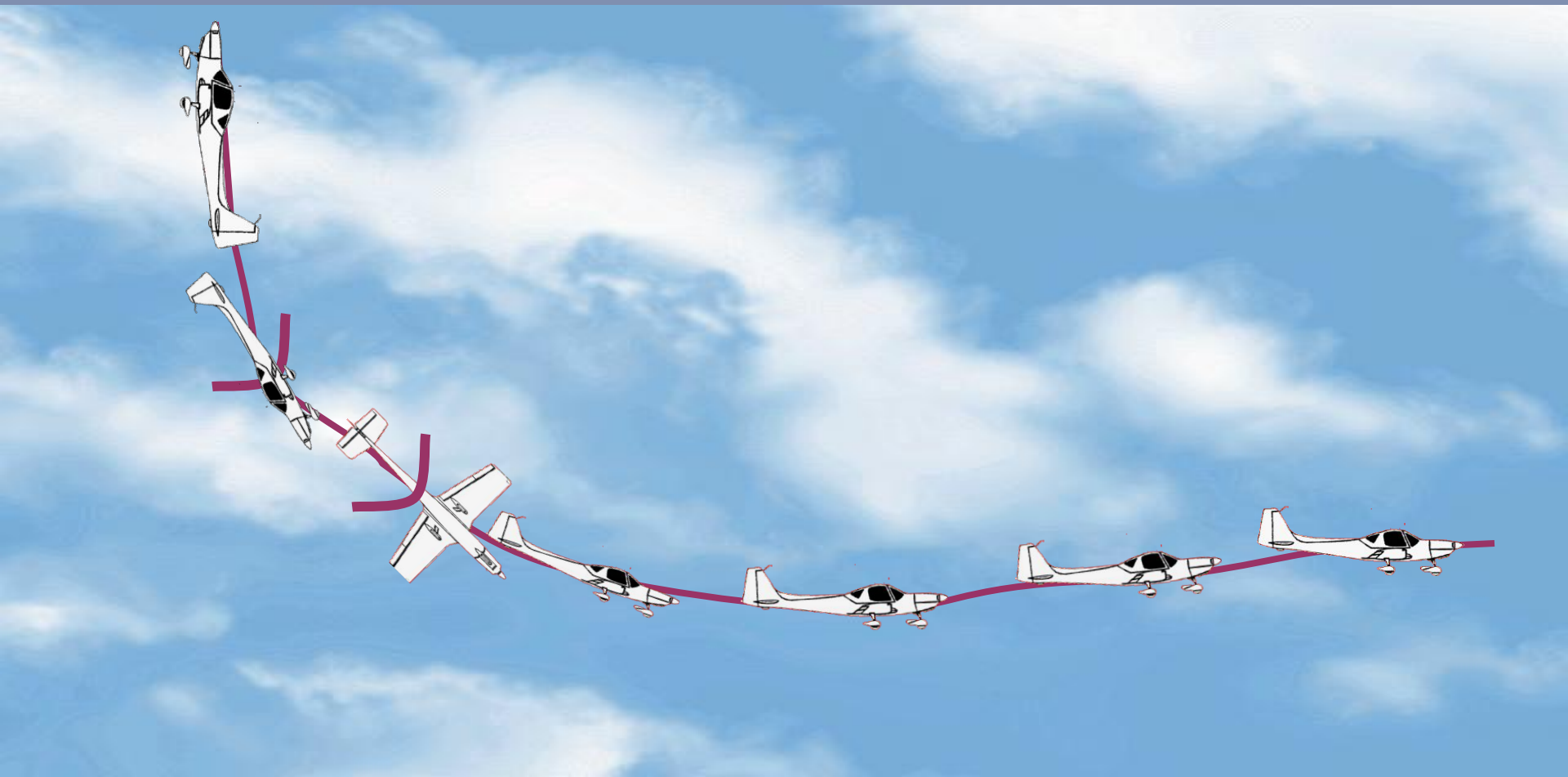
Advanced: Upward roll

- Process
  - Raise speed by dropping nose
  - Pull up vertically
  - Roll, keeping wings straight
  - Often ends with stall turn



Advanced: Aileron Turn

- Process
  - As half roll & pull through, but roll ours when vertically downward



Advanced: Derry turn

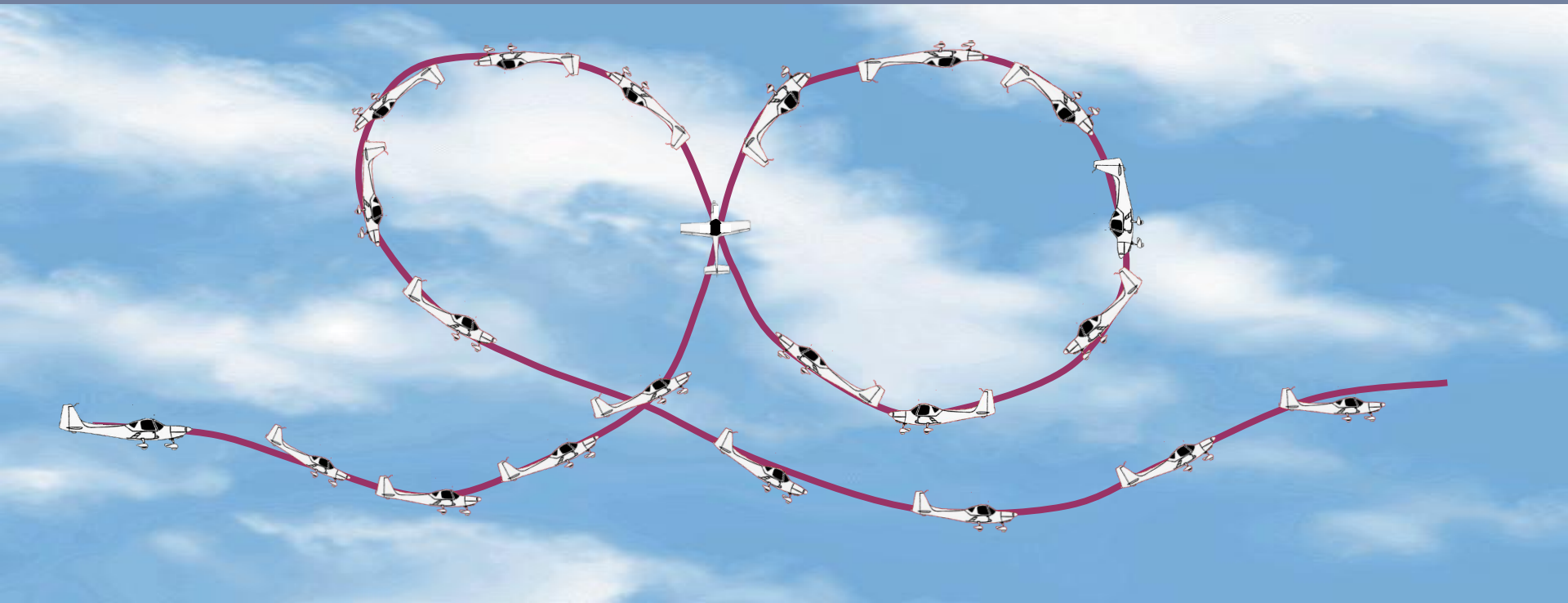
- Process
  - As half roll & pull through, but roll ours when vertically downward

Advanced: Vertical eight

- Process
  - As half roll & pull through, but roll ours when vertically downward
  - Care must be taken not to exceed Speed & ‘G’ limits

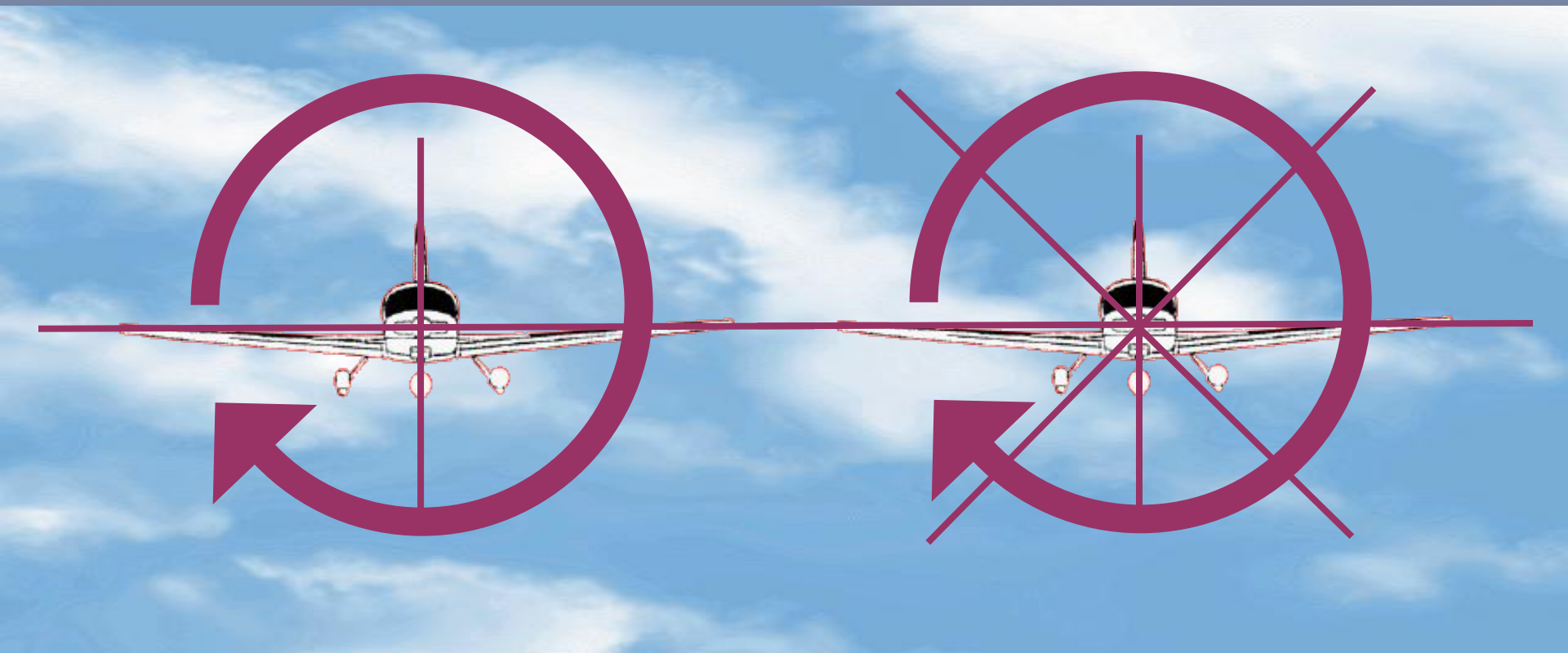
Advanced: Horizontal eight

- Process
  - As horizontal version of vertical eight



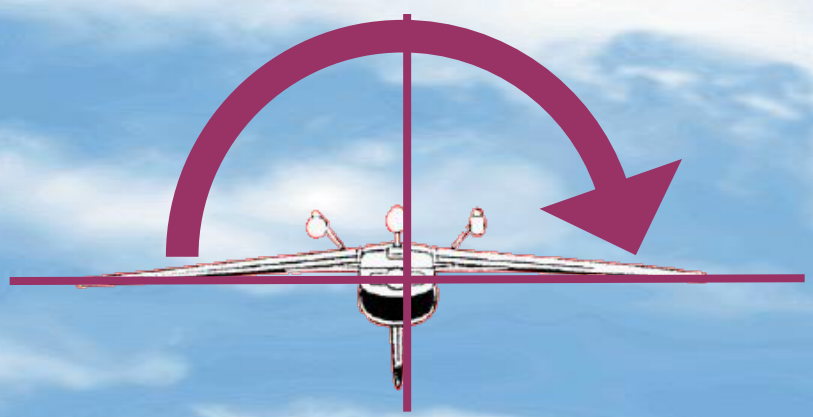
Advanced: Hesitation roll

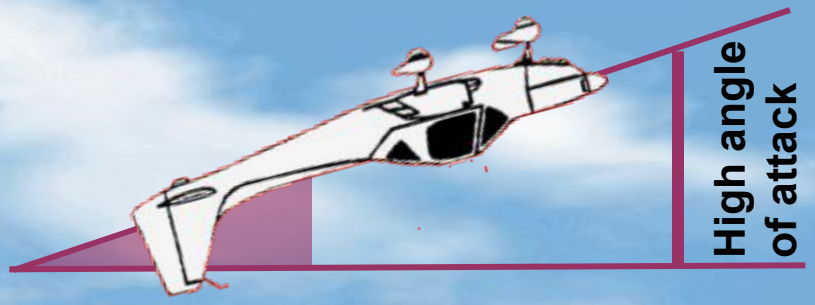
- Process
  - Either a 4 or 8 point roll, stopping briefly every 45° or 90°



Advanced: Inverted Flight

- Process
  - Few aircraft are permitted to fly inverted for prolonged periods of time
  - Airframes can manage more +ve than –ve ‘G’ forces
  - Inverted flight inverts the pitch controls
  - Lift decrease and stalling speed increases





Formation Flying

- "Ordered arrangement of 2 or more aircraft proceeding as an element"
- Leader is termed an "No 1" and is responsible for briefing & safety of all aircraft in the formation.
- No 1 is the only pilot who looks at instruments, all others watch & follow No 1 at ALL TIMES
- Two categories of formation flying:
  - **Close formation** – take off, cloud formation, display & air shows, landing
  - **Tactical formation** – used for tactical combat operations

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Formation Flying: Leadership

- Close formation flying is dependant on the leadership of No 1
- No 1 commands the formation, it's security, tactics, exercises & safe return to base
- No 1 must brief a Deputy in case of emergency
- Several sections can form up under the leadership of 1 section

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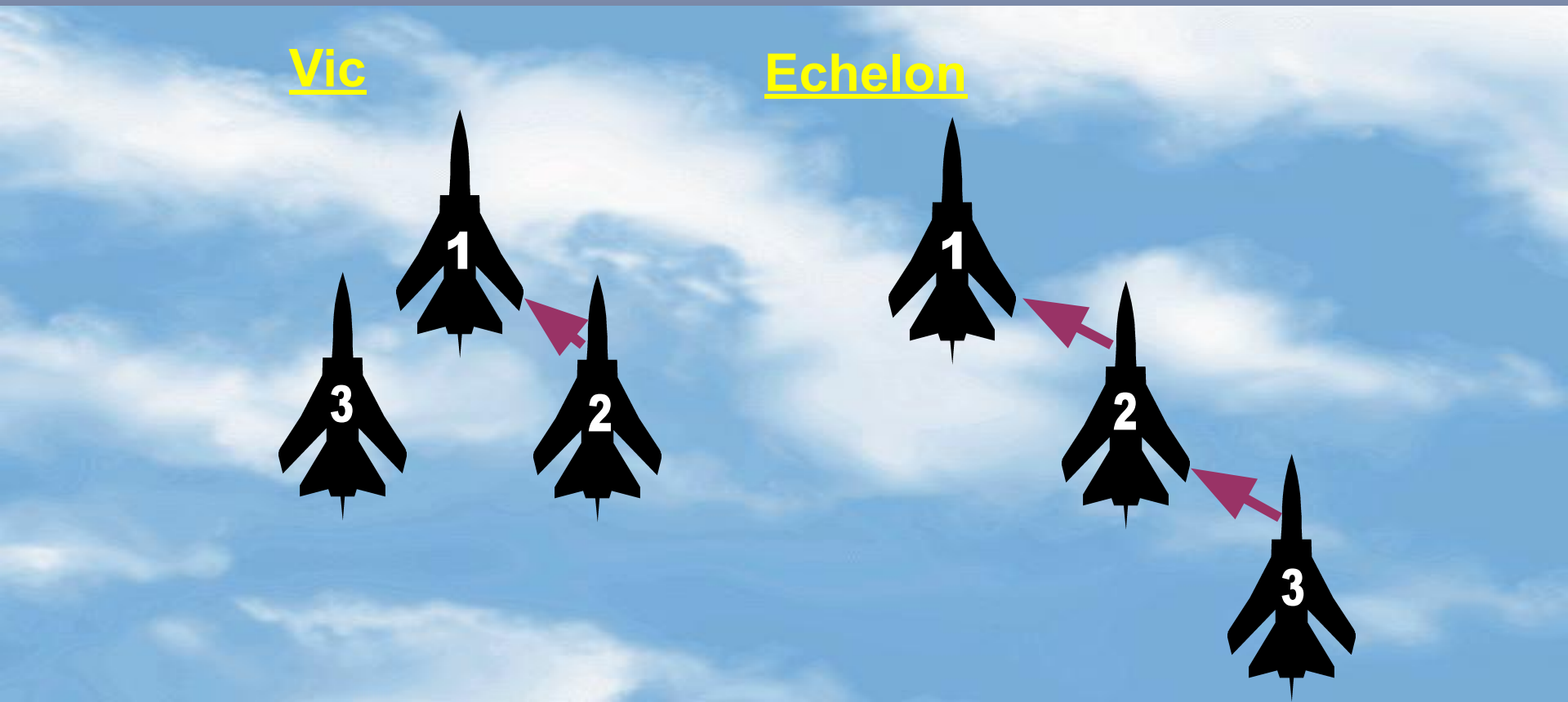
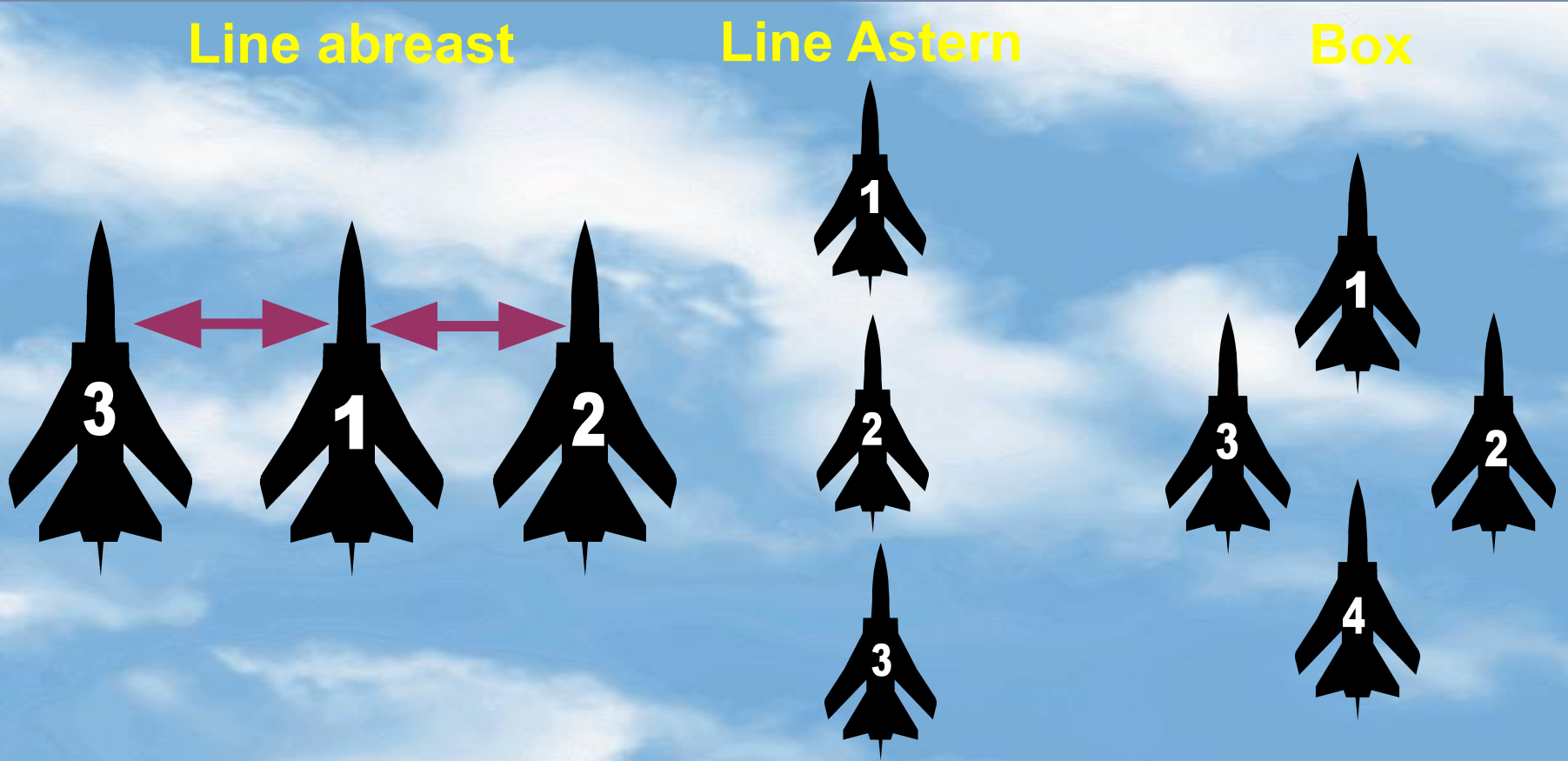
Formation Flying: Vic & Echelon & Line Astern

- Vic & echelon Positions between aircraft are fixed by a reference point – e.g. Wing tip
- Try to keep smoothness in formation with all in line



Formation Flying: Line abreast, line astern & Box

- Distance & stations kept by reference to cockpit & size
- In line astern relative distance is used



Close formation techniques

- **Relative speed** – the only method of judging speed is using the Air Speed Indicator (ASI)
- **Apparent size** – using the size of objects to judge distance – 6 miles to 3 miles isn't obvious, but 1 mile to ½ mile is.
- **Distance** – Tendency to underestimate, comes with practise & experience

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Joining Formations

- Does as quickly as possible to save time & fuel
- No 1 flies straight & level for 1 mile, allowing others to catch up
- No 2+ then join on a slow turn, remaining on starboard side of No 1 – 2 & 3 will swap
- No 1 flies at cruising speed allows others to catch up by aiming on collision course, then slowing into position

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Station changes

- Changes are always small & smooth
  - Longitudinal changes use throttle & elevators
  - Lateral changes use ailerons
  - Vertical changes use elevators
- A **clean aircraft:**
  - *Accelerates quickly*
  - *Decelerates slowly*
- Acceleration is often poor at low speed in jet aircraft

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Emergencies

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Recap

- Aircraft Maintenance
- Ground Handling
- Prep for Flight
- General Flying
- Aero's & Formation flying
- *Emergency procedures*

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Emergency Procedures

- Emergencies can happen at any time!
- All aircrew must have knowledge of emergency procedures
- Two degrees of emergency:
  - **Distress**: “The calling station has a very urgent message to transmit concerning the safety of an aircraft, or of persons on board or within sight”.
  - **Urgency**: “The calling station has a very urgent message to transmit concerning the safety of an aircraft, or of persons on board or within sight”.

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Emergency Transmissions

- In both cases the pilot must communicate with ATC by:
  - Radio Telephony - 243.0 MHz (Main), 121.5 MHz (Backup)
  - Wireless Telegraphy - 500KHz HF
- **Distress**
  - RT: Mayday, Mayday, Mayday [Aircraft call sign] x 3
  - WT: SOS, SOS, SOS [[Aircraft call sign] x 3
- **Urgency**
  - RT: Pan, Pan, Pan [Aircraft call sign] x 1
  - WT: XXX, XXX, XXX [Aircraft call sign] x 1

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PAT HAS ATNIE

- Remembered by the pneumonic:

PAT HAS ATNIE

Position **A**nd **T**ime **[PAT]**

Heading and **A**ir **S**peed **[HAS]**

Altitude

Type of Aircraft

Nature of Emergency

Intentions of Captain

Endurance Remaining

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Emergency Procedure and Fixer Service (1)

- **Secondary Surveillance Radar:**
  - SSR is used to indicate an emergency
  - code 7600 indicates a total radio failure
  - If an emergency occurs when in contact with an ATC agency, the SSR code already set should remain in use unless advised otherwise by ATC. In all other cases the transponder should be set to code 7700.
- **Final Transmission**
  - When ditching, crash landing or abandonment is imminent, the aircraft callsign should be transmitted and, where possible, the transmit control switch should be left in the transmit position.
  - For W/T the key should be clamped in the transmit position. These actions should not take priority over abandonment if life would be endangered by so doing.

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Emergency Procedure and Fixer Service (2)

- **UHF Emergency Fixer Service**
  - Within the UK FIRs a network of stations provide an emergency fixer service.
  - Emergency transmissions on 243 MHz are picked up by stations within range, and a bearing of the aircraft making the transmission from the station is automatically relayed to the ATCC
  - Accurate to 5000 feet – 8500ft in Scottish FIR
- **SARSAT**
  - Search And Rescue Satellite Aided Tracking
  - Any calls on emergency frequencies activate rescue services
  - False alarms should be reported ASAP to stand down ES
- **Cancellation**
  - If emergency ceases call must be cancelled on all emergency frequencies used

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Emergencies & other vehicle

- **Visual emergencies with other aircraft**
  - Keep aircraft in sight
  - Guide in any other aircraft, vessels or vehicles
  - Contact ground controller
  - Captain to comply with special instructions from ground controller
- **Radio emergencies with other aircraft**
  - Take bearing on transmission & plot position if possible
  - Listen out on appropriate frequencies
  - If no acknowledgement is heard, call aircraft
  - Listen out for instructions from ground control
  - At captains discretion, proceed to emergency location

Emergency Organisations

- **ATCC Distress & Diversion Cell**
  - Aircrafts in distress may make contact with an ATCC or ATCRU by:
    - transmitting an emergency message on the frequency in use,
    - transmitting on the emergency frequency
    - by a relay transmission from another aircraft
    - by flying the triangular patterns
  - When the ATCC has identified an aircraft in distress, executive authority for the handling of the emergency is passed to the Emergency Controller in the ATCC Distress and Diversion Cell.
- **Search & Rescue Services**
  - Emergency controller will advise the Rescue Co-ordination Centre (RCC) (2 x RCC in UK, Plymouth & Edinburgh)
  - The RCC co-ordinates the activities of all SAR facilities which may include: SAR helicopters, lifeboats, long range maritime patrol aircraft, mountain rescue teams and police and ambulance services.

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