CIVIL AVIATION AUTHORITY OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

CIRCUIT TRAINING

Forced Landing without Power Pattern

This briefing covers the determination of wind direction, the selection of the most suitable landing site, initial configuration of the aeroplane for best gliding performance, and the pattern flown to achieve a successful forced landing. The *Considerations* lesson covers checks and further decision making considerations.

We have already discussed the main reasons for engine failure (fuel, air, spark) in the *Engine Failure after Takeoff* lesson and how sensible precautions can minimise risk – preflight inspection and planning, run-up, checks, safety brief and SADIE .

In addition, the student is familiar with the need to produce an automatic response in emergency situations, and with the glide approach.

This lesson discusses the ideal procedure to follow in the unlikely event of a total or partial engine failure in the cruise at altitude (above 1000 feet agl as a guide) where more time is available to plan and consider options than the EFATO. Later exercises will provide practise in adopting this procedure from a lower altitude.

A partial engine failure or rough running is more common than a total failure, but this is still rare. The recommended procedure for dealing with the partial power failure begins with the same steps as a total failure, and therefore the pattern is relevant to both.

A total power failure will be simulated by closing the throttle.

Objective

To be able to select an appropriate landing site and carry out the pattern for a forced landing without power.

Considerations

Configuration

State the configuration required to achieve the best L/D ratio for the aeroplane (________ knots, no flap and propeller windmilling), and its effect on range. The effect on range of using other airspeeds will be discussed in the next briefing, *Forced Landing without Power – Considerations*.

> Although drag is reduced by stopping the propeller, this procedure is not recommended, or required, to achieve the objective of this lesson (refer CFI).

Wind Indicators

The various methods of determining the wind speed and direction are discussed, with initial emphasis on direction, because the plan is based on wind direction. Adaption of the plan is needed when wind strength is recognised, and in the latter stages of the plan.

The most relevant indicators are those at ground level: smoke, dust, crop movement, tree/leaf movement, wind lanes and wind shadow on water, and drift.

Smoke

Smoke is a clear indication of wind direction and strength, and rarely available when you need it.

Dust

Dust from dirt roads, river beds or ploughing, as well as ground spread fertiliser, may indicate wind direction and strength.

Crop Movement

Ripples move downwind across the top of crops, especially wheat and hay fields.

Tree/Leaf Movement

The tops of Poplar-type trees lean with the wind.

Willows, after initial spring leaf growth, indicate wind by showing the silver underside of their leaves in winds of 8–12 knots or more.
The silver side of the tree is the windward side.

Wind Lanes

Wind produces effects on the surface of the water. Light winds, 5–15 knots, can ruffle the surface and, when viewed up or down wind, these disturbances form streaks of parallel lines, indicating the wind direction – but it can be difficult to resolve the 180-degree ambiguity unless wind shadows exist near the shore.

Above 15 knots, the wind may drive spray or foam in parallel lines. These too can be misinterpreted by 180 degrees, although the streaking may be more marked when looking downwind compared with the upwind.

Fresh water typically forms white caps at 12–15 knots, and seawater at 15–18 knots.

Waves and Ripples

Waves and ripples form at right angles to the wind and move downwind. The first whitecaps appear between 7 and 10 knots. From altitude, however, it may be difficult to determine the direction of wave movement.

Wind Shadow

Wind shadow can be seen at the upwind end of a lake or pond. It is an area of calm water where the shoreline protects the water from the wind, creating an area of calm water. This effect is most noticeable in winds of 5 knots or more, when the sunlight reflects off the water's surface. A small version of this can be seen as you walk out to the aeroplane after rain. Puddles of water will display this same effect when the wind is blowing. Wind shadow is best seen on small ponds or lakes of stationary water, rather than large expanses of water.

Any indication of wind seen in flight should be noted in case it is needed in the future.

Cloud Shadow

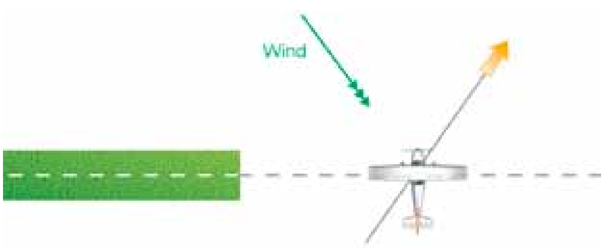
The movement of cloud shadow over the ground gives the wind direction and some indication of speed, at the cloud level. This is used only as a guide, however, as the wind on the ground will probably be different. Likewise, the 2000-foot wind and area forecasts are only a guide to the wind's general direction and strength. Apply local knowledge and orographic effects to estimate the wind on the ground.

Drift

Drift can be useful, as it is what you are experiencing at altitude, but it takes experience to recognise it correctly. Be aware that it can be induced by flying out of balance.

The pilot needs to develop an awareness of where the aeroplane is heading compared to where it is tracking. When flying across the extended centreline of any landing area, if drift is present it can be seen.

Figure 1



Local Knowledge

The other means of determining wind direction and strength are related to local knowledge and the aerodrome of departure. Local knowledge includes terrain and local effects, such as anabatic or katabatic winds, and sea or land breezes. Relevant conditions at the aerodrome of departure include the 2000-foot wind forecast, the windsock and the known takeoff direction. The usefulness of these indicators is relative to the distance of the aeroplane from the aerodrome – and the intervening terrain.

Choice of Landing Site

The choice of the most appropriate landing site is usually a compromise and is discussed using the mnemonic *the seven S's, C and E*.

The seven S's are: Size, Shape, Slope, Surface, Surrounds, Stock and Sun. The C is Communication and E is for Elevation.

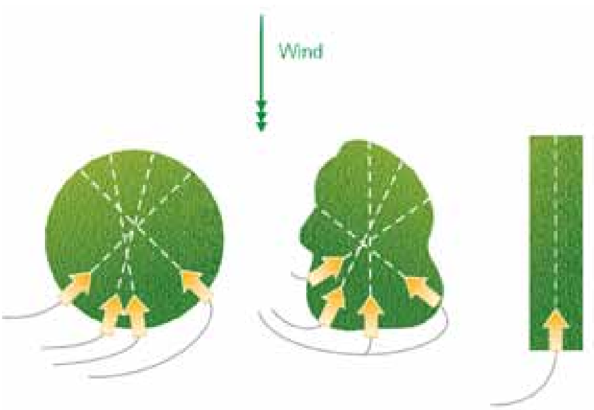
Size

The ideal is for the longest possible landing area into wind, within gliding distance (to be discussed further in the *Considerations* lesson).

Shape

Shape is mentioned because the student may limit their search for a landing site to only those sites that resemble a runway. In fact, the perfect shape is a circle, as multiple approach paths into wind are available. Even a square is preferable in contrast to a narrow paddock with only one approach path.

Figure 2



Slope

An uphill slope for landing is preferred over level ground. A down-slope should be avoided – it would take a very strong wind to override the disadvantages of a downhill landing. Slope can be difficult to detect at altitude, and when slope is apparent from altitude, generally the terrain is very steep. However, water runs downhill, so creeks that narrow give some indication of slope (ie, they are narrow at the higher end) and the dam wall on farm water storage ponds also indicate downhill slope. Significant 'white water' in any flow indicates significant gradient.

Surface

A firm surface is recommended, not so much for stopping distance but to avoid the nosewheel digging into the soft surface and somersaulting the aeroplane. Determining the type of surface from altitude can be done by comparing the texture of the local aerodrome's grassed areas with those of various paddocks.

Surface also includes anything on the surface, such as stock, crops, fences and stumps.

Surrounds

Where possible a landing site that has a clear field on the approach end and the upwind end should be chosen to provide for undershoot and overrun during the forced landing. For the training exercise, a clear go around and climb-out path is also considered.

An approach over a road will quite likely bring you into contact with power wires running along the road.

Sun

Sun is normally only a problem at sunrise and sunset, particularly in winter. Under these conditions an approach in the direction of the sun may blind the pilot on final. Accepting some crosswind may be better than an approach directly into a low sun.

Communication

All of the previous factors are the priority, but if there is a choice available to land near habitation, especially where there is little of it, it will put you closer to help. For example, if you are over a ridge and to one side is a remote area and the other has habitation – choose the habitation.

Elevation

Based on local knowledge, charts or comparing the altimeter reading with terrain perspective, the height above sea level of the landing site needs to be estimated. This is because the procedure is planned on heights above ground level but flown on heights above sea level with reference to the altimeter.

The pilot should be able to recognise heights without the use of the altimeter, for example, the circuit height is generally 1000 feet – have the student fix that as a metal picture they can use during this exercise. Do the same for 500 feet and 1500 feet.

Situational Awareness

The ability to quickly implement the forced-landing procedure is markedly enhanced by good situational awareness. Throughout the flight the pilot should observe wind indicators and the approximate elevation and suitability of the surrounding terrain. This does not require the pilot to choose a specific forced-landing site and update it continuously in cruise. By taking notice of their environment the pilot should know where the wind is coming from and where in relation to the aeroplane, the more suitable terrain is for a forced landing. Should an emergency develop, an immediate turn toward this area is made and then a specific field chosen.

Choosing a flight path that takes into account the terrain over which they are flying shows good airmanship.

Airmanship

Revise the checks that will only be carried out by touching the control.

The student should be advised that, although this exercise may be carried out solo – with clear limitations imposed – it is illegal to carry anyone other than people performing an essential function during forced-landing practise.

Simulating Engine Failure

There are at least two methods of simulating the engine failure. Your CFI will determine the organisation's practice. Simulating engine failure in a variety of ways is more likely to expose the student to the real life possibilities, and they are more likely to react appropriately, rather than to just one particular stimulus.

One method is to set the mixture to idle cut-off, thereby encouraging the student to close the throttle and apply carburettor heat, as they would in the real situation. If using this technique make sure the throttle is fully closed before returning the mixture to RICH.

Another method is to partially close the throttle, and leave the student to respond by selecting carburettor heat to HOT and closing the throttle.

Once the student has gained some competence in this exercise you can introduce engine failures with little or no warning – as it would be in the real world.

The simulation is ended with the instruction to "go around", at which point the student is to immediately carry out a go around. In later lessons more emphasis will be placed on the student's decision making to initiate the go around without prompting.

It is also important, in later lessons, for the student to complete the exercise through to the landing. This can be completed by conducting the forced landing over an appropriate aerodrome.

Dual forced landing practise qualifies as a bona fide reason to fly below the height prescribed in 91.311(a)(2). See 91.311(c) for the conditions required.

When practising solo, unless operating in a Low Flying Zone, the go around will be at 500 feet agl (see CFI for the organisation's limits).

Aeroplane Management

As a prolonged climb will be required before starting the exercise, a period of level flight is recommended to allow the engine temperature to stabilise before closing the throttle.

To maintain adequate engine operating temperatures and pressures during the prolonged glide, the engine is warmed or cleared every 1000 feet (minimum) by smoothly opening the throttle to full power and closing it again. This ensures that normal power will be available for the go around, clears the spark plugs of lead/carbon deposits and puts warm air through the carburettor, preventing ice build-up. If the engine runs rough during the engine warm, consider warming or clearing more often (every 500 feet), delay closing the throttle again until smooth running is achieved, or begin the go around immediately or at a considerably higher altitude than the minimum. This will depend on the engine's running characteristics and the terrain.

> There is no need to select carburettor heat COLD during the engine warm as no attempt is being made to continue using full power. In addition, the effectiveness of the carburettor heat is dependent on engine temperature, therefore, the application of full power will ensure carburettor ice is cleared.

Human Factors

Avoid turning your back on the chosen landing site.

Information processing loads are high in this first lesson, but with practise the overload will reduce, and more information can be introduced.

Avoid mindsets by revisiting and evaluating any decisions made, especially those relating to wind.

Air Exercise

The exercise starts from an appropriate cruising altitude (refer CFI), not a height above ground level, as the aeroplane is normally flown by reference to the altimeter.

The initial actions, planning and flying the procedure are discussed.

Immediate Actions

Apply carburettor heat and close the throttle. Carburettor heat will remedy a real icing problem or prevent one during the simulation.

Convert excess speed to height, since there may be an appreciable difference between the cruise speed and the recommended glide speed. The average training aeroplane may not actually increase height, but at least preserve it.

Set glide attitude and trim. As the best glide speed is approached, allowing for inertia, the attitude is selected for the glide and the aeroplane accurately trimmed to maintain this attitude.

Confirm wind direction and select suitable landing area. If situational awareness has been maintained, the wind and the approximate elevation of surrounding terrain are confirmed. The aeroplane is turned toward the most suitable area for a forced landing. It should be stressed that – if the student has not been maintaining their situational awareness – valuable time will be wasted while these factors are assessed.

Make the plan. See the notes below on making and executing the plan.

Make a MAYDAY call (simulate only during training)

Trouble Checks

When there is time available for diagnosis, as there is during a forced landing, carry out the *Trouble Checks* to see if you can get the engine restarted.

F ***F**uel*

Selector ON, fuel pump ON (if applicable), change tanks (touch).

Fuel pressure and the contents gauges are checked and compared with the fuel tank selected.

M Mixture
RICH, carb heat HOT, primer LOCKED.

These are checked and the mixture, in the case of partial power, altered (touch) to see if there is any improvement in power or smoothness.

I Ignition
LEFT, RIGHT or BOTH (touch), check temperatures and pressures

Trying LEFT (touch) and RIGHT (touch) magneto positions for smoother running may keep the engine running. Try to restart the engine with the ignition key if the propeller is not windmilling (touch).

Check the temperatures and pressures for any reading outside the green range.

P Partial Power
Check

Set the throttle to about one third open to see if any power is available. If no power is available, the throttle must be closed again so as to prevent the engine unexpectedly bursting into life at an awkward moment. In the simulated exercise the partial power check serves to warm the engine.

The Plan

A specific landing site or the best compromise needs to be chosen and the approach planned.

Planning the approach begins with selecting a minimum of three reference points:

- an aiming point 1/3 of the way into the field in the landing direction
- a 1000-foot agl area
- a 1500-foot agl area

The aim is to fly the approach as similar to a lefthand circuit as possible, unless terrain, cloud, obstacles or gliding distance favour a right hand circuit.

Start selecting the points from the ground up as there is little point choosing a 1500-foot area if you are 1300 feet.

Stress that the 1000-foot and 1500-foot references are above ground level, and that these provide valuable orientation information if the landing site is lost from view.

> Some organisations recommend an additional 2000-foot agl area (refer CFI).
>
> When the considerations of a righthand circuit are introduced (refer CFI), the plan is simply flipped over, to produce a mirror image on the righthand side of the landing site.

Landing Aim Point

The first step is to divide the available landing distance into three and choose a definite reference or aiming point at about 1/3 of the way into the field. The logic behind this is that it is better to taxi, even at high speed, through the far fence than to fly into the threshold fence.

Although a positive reference point on the field is best, it does not have to be in the field itself, but can be abeam the 1/3 aiming point, one or two paddocks over.

1000-foot Area

The 1000-foot area is at 90 degrees, or right angles to the threshold, usually 3/4 of the normal circuit distance out (refer CFI). This area should be about the size of a football field or four to six suburban residential sections.

> There is a natural tendency for the student to hug the field, resulting in a very tight turn to final and little or no opportunity to adjust the approach. The downwind leg should never be closer than three-quarters of normal circuit spacing.

1500-foot Area

The 1500-foot area is a larger area further back from the 1000-foot area.

From anywhere within this area, at 1500 feet agl, it will be possible to glide to the 1000-foot area and arrive at about 1000 feet agl.

This area may be over the field if low, or swung out wider than downwind if high, as if the aeroplane is on a string held at the 1000-foot area.

Altitudes

The next step in the planning process is to transform the 1000-foot and 1500-foot areas into altitudes that will be seen on the altimeter, by adding on the estimated elevation of the chosen landing site.

> It will be shown a little later how the downwind spacing compensates for any error in the estimate of elevation. A point worth making here is that it is always better to overestimate than underestimate and that if there is any doubt, add two or three hundred feet onto the estimate of the landing site elevation.

Positioning

The most important part of the plan is assessing progress into the 1500-foot area from wherever the aeroplane happens to be.

The ideal procedure starts from the non-traffic side, flying parallel to the chosen landing site to provide a standard reference to which variables can then be applied during later training.

The positioning process is assisted by asking at regular intervals, "Am I confident of reaching the 1500-foot area at ________ feet?" If any doubt exists, a turn toward the area should be started immediately. If no doubt exists, the turn can be delayed.

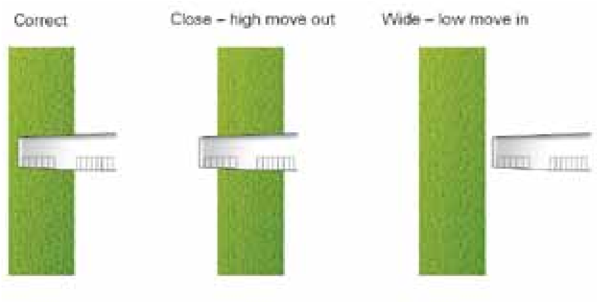
Reconfirming wind, especially wind speed estimates, by acknowledging drift may result in a plan adjustment, especially in stronger winds.

Once the 1500-foot area has been passed, the aeroplane is positioned on the downwind leg.

Spacing

On the downwind leg it is vital that the spacing is assessed in relation to the nominated point on the aeroplane's airframe to establish the correct circuit spacing. It is this process that compensates for any misjudgement at the 1500-foot area, and any error in estimating the landing-site elevation.

Figure 3



Caption: An example of how spacing is assessed using the parallel markings on a low wing aeroplane.

In a high-wing aircraft, position the 'runway' within the outer third of the strut.

In the classroom, put a piece of paper, representing the landing site, on a desk or the floor and give the student a model aeroplane. Ask them to stand in the downwind position and place the model at the chosen downwind spacing.

By lifting the model aeroplane higher, you can show that the aeroplane is now too close or too high. At the new height the student must move out from the landing site to once again position the airframe feature onto the diagram.

Lowering the model will have the reverse effect (too wide or low) and force the student to move in toward the diagram to re-establish the correct spacing.

At the 1000-foot area, abeam the threshold, the approach phase starts.

The Approach

How soon the base turn is started depends on the wind strength. Strong wind, turn sooner. Light winds, turn later.

The base turn can be adjusted but **never extend the 1000-foot area downwind**.

The aeroplane should be turned to track on base leg at 90 degrees to the landing direction.

From the base leg, further adjustments can be made if necessary. If the approach appears too low, the turn onto final can be made early. Conversely, if too high, the base leg can be extended or the turn widened to pass through the centreline.

Throughout the approach, from the 1000-foot area down to approximately 500 feet agl, continual reference is made to the 1/3 aim point and to maintaining glide speed. No checks are carried out during this segment. The student should be familiar with the glide approach as covered in the circuit lessons.

It is very important to offset drift during the base leg, so as to ensure that the aeroplane tracks correctly in relation to the field.

The student should be repeatedly asking, "can I reach the 1/3 aim point?"

In extremely strong winds, or if a headwind is encountered on base, this may require the aeroplane to be turned to point directly to the 1/3 aim point.

The aim of this process is to position the aeroplane at about 500 feet, so as to touch down at the 1/3 aim point, preferably without flap.

If there is a need to use flap earlier, because you are grossly high, then flap is used. Application of flap in stages is used to bring the actual landing point back toward the threshold from the 1/3 aim point, so as to make maximum use of the length available.

The approach and landing phase of this lesson will be covered in more detail in the following *Considerations* lesson.

Airborne Sequence

On the Ground

No new material included here. The student should know all of the checks on the ground and be able to take you to the training area with little input from you.

The Exercise

During the climb and transit to the training area point out the various wind indicators and surface types (ploughed, swampy). Encourage the student to evaluate the field type while they are carrying out the go around. Also, give the student some opportunity to practise estimating the elevation of various landing sites, preferring a rounding-up estimate if in doubt.

Before Starting

Before starting the exercise, all available indicators of wind should be observed or discussed, the initial forced-landing site pointed out, and the student asked to estimate its elevation.

The various reasons for choosing the landing site are discussed in relation to the seven S's, C and E.

> The introduction to forced landing without power is never carried out onto an aerodrome or agricultural airstrip. This is because a major part of this exercise deals with assessing the wind without a windsock or known active runway and the suitability of the landing site, which is not a designated landing area. In addition, all airfields attract aircraft and have an aerodrome traffic pattern around them, requiring radio calls to be made for the information of other traffic. Even if you carry these out, they form a distraction to the lesson.

The planning process is discussed next, specifically choosing the 1/3 aim point, the 1000-foot area, the 1500-foot area, and how to initially achieve the 1500-foot area.

Throughout this process, the chosen landing site is kept on the left of the aeroplane (student's side) and the aeroplane is held in a gentle level turn so that the landing site can be continually observed.

> There are two common errors an instructor can make.
>
> 1. Getting too close to the landing site, requiring steep angles of bank or flight out of balance to observe the field. At the heights commonly used to start this exercise, the aeroplane needs to be at least 2 NM away from the field (at least twice circuit spacing).
> 2. Not allowing for drift during the gentle turn to observe the landing site – a constant radius turn is required to maintain a constant distance.

The Pattern

Before the throttle is closed to simulate the engine failure, all the considerations of wind, elevation, landing site and reference points are discussed. The aim is to demonstrate the ideal forced-landing pattern, and later exercises will require the student to adapt this pattern for the conditions under which the power failure is simulated.

The value of the demonstration/patter will be negated if the student is not aware of which landing site is being used and what features define the 1/3, 1000-foot and 1500-foot references.

The engine failure will be simulated from ________ feet by closing the throttle. The first demonstration/patter and student practise should be conducted at a suitable altitude so as to introduce the exercise gently and allow them time to put the briefing items into practice.

It is recommended that the exercise begin with the initial actions and a demonstration/patter. This should consist of how the aeroplane is being positioned for the 1500-foot area, the use of spacing downwind to make the 1000-foot area, and how to fly the base leg to make the 1/3 aim point. The checks will be covered in the next lesson.

The aeroplane is positioned on the non-traffic side of the chosen landing site, facing into wind, preferably at least 2500 feet agl to give information-processing time. Closing the throttle is at your discretion so, once all relevant points about the approach have been observed by the student, position the aeroplane appropriately and start the simulation.

Carburettor heat is selected to HOT, the throttle closed, the initial actions carried out and the plan activated. Except for the regular engine warm, no other checklists are completed.

Throughout the approach you should draw the student's attention to the relevant features and wind. The 1500-foot area is relatively easy to achieve because it is such a large area, and the 1000-foot area cannot be missed if the spacing is correct. Problems invariably arise in the judgement of the approach to the 1/3 aim point. This is because the student has spent several hours in the normal circuit, and all their experience in judging an approach has been in relation to a threshold or runway end. It is vital, throughout the base leg, that you repeatedly draw the student's attention to the 1/3 aim point and ask if the student is confident of placing the aeroplane's wheels on the ground at that point.

Judgement of whether the 1/3 aim point can be reached or not is facilitated by maintaining a constant airspeed and noting whether the aim point moves up the windscreen, down the windscreen, or remains constant.

At this point the objective of this exercise has been achieved. The measure of success is whether or not the 1/3 aim point could be easily reached from this position. Regardless of the answer to that question, you tell the student to go around. You or the student must assess whether an earlier go around is advisable due to turbulence, terrain, stock or nearby habitation.

In following lessons the aeroplane will be taken below 500 feet and the student will have the opportunity to more accurately assess if the aiming point will be reached.

The aeroplane should be repositioned to the ideal forced-landing start position using the same landing site for student practise.

Student Practise

The student should be encouraged to say how confident they are about reaching the 1500-foot area and the 1/3 aim point and their allowance for the wind. If not, you may need to prompt the student with questions, especially if you doubt the aeroplane's ability to reach the nominated references.

Do not use terms such as:

1. "This approach looks high/low/correct."

   Emphasise what the student should be looking at to judge the approach: "This approach looks high in relation to the water trough (1/3 aim point)."

2. "Delay flap until you're sure of getting in." You could be "sure of getting in" from 3000 feet agl over the landing site!

   Emphasise, "Delay flap to about 500 feet agl and ensure the water trough (1/3 aim point) can be reached." Provide for exceptions, by stating that "If flap is needed then use it."

3. "Can you make/reach the field?" This draws the student's attention away from the 1/3 aim point to look at the overall landing site. Students who go high/overshoot are usually doing this. Students who go low/undershoot are always looking at the threshold.

   Emphasise the 1/3 aim point, eg, "Can you reach the water trough?"

Where possible, this exercise concludes either with a demonstration forced landing onto the home aerodrome, or the student is encouraged to fly the pattern down to about 500 feet agl. During the latter exercise, you make all radio calls so that the student can concentrate on the pattern. Maintain situational awareness and beware of other traffic, as a simulated forced landing does not give you automatic right of way.

After Flight

The handout on this lesson should include a complete set of checks to be learnt before the next lesson.

Your student will be ready for solo exercises to the training area soon, and they should be showing progress in that direction. Encourage them to work on any weaker areas before they are sent solo.