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



# Circuit Introduction

The circuit is an orderly pattern used to position the aeroplane for landing and minimise the risk of collision with other aircraft.

Airfields attract aircraft, therefore rules and procedures are required to maintain an orderly sequence or flow of traffic. Knowing that all aircraft should be following these published procedures makes it easier to identify which runway should be used, where other aircraft are (or can be expected to be), and who has the right of way (or priority) in the sequence to takeoff or land.

**Having the right of way does not absolve the pilot-in-command from avoiding a collision.**

The standard circuit pattern or procedure, and the rules to be employed around specific aerodromes are published in *AIP New Zealand*. The rules governing circuit procedures are contained in Part 91, Subpart C.

The skills the student has acquired leading up to this lesson combine so that there is only one new skill to be learnt now – landing the aeroplane.

This briefing is based on the normal lefthand circuit, assuming nil wind or at least wind straight down the runway, with variations to this gradually introduced. Aim to introduce this lesson under ideal conditions. Obviously this will not always be possible and the briefing will need to be modified for the actual conditions on the day. In addition, discuss with your supervisor or CFI the acceptable weather conditions for this lesson.

## Objectives

To takeoff and follow published procedures that conform to the aerodrome traffic circuit, avoiding conflict with other aircraft.

To carry out an approach and landing using the most suitable runway.

## Considerations

### Takeoff

Even though the student will probably have completed a number of takeoffs already, this is an important review of what they may know already, but also introduces some new considerations.

#### *Slipstream*

In aeroplanes where the propeller rotates clockwise, when viewed from the cabin, the effect of slipstream is to apply a force on the port side of the vertical tail fin, and this will tend to yaw the aeroplane to the left at high power settings. This effect is greatest during the takeoff roll as a result of the high power and low airspeed.

#### *Torque*

The effect of torque, the force that tries to rotate the aeroplane rather than the propeller, is to cause increased downward pressure to be applied to the left main wheel. This results in increased resistance on this wheel, yawing the aeroplane to the left.

There are two more effects, but these apply more significantly to tailwheel aeroplanes.

***Asymmetric Blade Effect***

Asymmetric blade effect is the result of the down-going blade of the propeller meeting the relative airflow at a higher angle of attack than the up-going blade. This effect is noticeable with tailwheel aeroplanes; it will only affect tricycle types in the rotate or climb. It results in the thrust force being slightly offset to the right (in clockwise rotating engines, as viewed by the pilot) and thus a tendency to yaw to the left.

***Gyroscopic Effect***

The gyroscopic effect occurs when the tail is raised to the level attitude. This causes a force to be applied to the propeller disc, the effect of which will be to produce a turning moment, which acts at 90 degrees in the direction of propeller rotation. Gyroscopic effect has no practical application to tricycle types.

### *Keeping Straight*

Emphasise that rudder should be used as required to keep the aeroplane straight during the takeoff roll by reference to a feature at the far end of the runway, and if available, the runway centreline. Whenever power is changed the aeroplane will yaw, and must be corrected with rudder.

### *Crosswind*

The tendency for the aeroplane to weathercock (point nose into wind) during the ground roll or while taxiing, as a result of a crosswind pushing on the empennage is explained, and the need to keep straight on the reference point is restated. In the air, allowance for drift is necessary to track towards any reference point.

### *Headwind*

The presence of a headwind reduces the length of the ground roll and in an extreme example, if the aeroplane was parked facing into the wind, and the wind was blowing at ________ knots, the aeroplane would be about to get airborne, and they sometimes do in strong winds if not tied down well.

There will be no drift experienced if the wind is directly ahead of the aeroplane, and there is no crosswind component.

### *Tailwind*

A takeoff with the wind would require the aeroplane to be accelerated to the wind speed just to bring the airflow over the wing to a standstill, a further ________ knots would be required to get airborne, greatly increasing the takeoff distance required, for example, just 5 knots of tailwind increases takeoff distance by 30 percent.

Taking off with a tailwind results in a shallow angle of climb, reducing obstacle clearance.

### *Climb Angle*

If the wind was blowing at 70 knots and the aeroplane was in a 70-knot climb, to a ground observer the aeroplane would appear to rise like an elevator, as the distance travelled forward over the ground would be zero. Therefore, the angle of climb is increased (ie, is steeper) into wind, improving obstacle clearance.

### *Takeoff into Wind*

For the above reasons, all takeoffs are into wind, to minimise the ground roll and takeoff distance, and to improve the climb angle.

**Ground roll =** brake release to liftoff.

**Takeoff distance =** distance taken to achieve height of 50 feet.

» both are affected

### *Power*

Use full power to minimise the takeoff roll and ensure climb performance.

### *Flap*

Flap increases lift and drag. Because of the drag increase, most light aeroplane Flight Manuals do not recommend the use of flap for a normal takeoff, although this will depend upon the runway surface.

***Surface and Slope***
Discuss factors that are applicable to the runway being used.

### Landing

***Wind***
Landing into wind reduces the groundspeed, requiring less stopping distance and therefore a shorter landing distance and ground roll.

**Ground roll =** wheels-on-the-ground distance.

**Takeoff distance =** from 50 feet above threshold to full stop.

both are affected

Once again if the headwind is 70 knots the aeroplane would not need to move forward at all to descend at 70 knots. Therefore, a headwind steepens the approach and improves obstacle clearance.

***Flap***
Flap increases lift and drag. The increased lift lowers the stall speed and permits a lower and safer landing speed, which will also reduce the ground roll. The increased drag allows a lower nose attitude for the same airspeed, and it increases the rate of descent, steepening the approach which provides improved forward visibility and obstacle clearance.

***Power***
Power controls the height or rate of descent. As discussed in the *Climbing and Descending* lesson, increasing or decreasing the power alters the rate of descent.

The increased rate of descent as a result of using flap is countered by the use of power to control the rate of descent. In addition, the use of power provides a slipstream effect that makes the rudder and, more significantly, the elevator more effective. Therefore, in a modern light aeroplane the normal approach is a powered approach using full flap. The various reasons for limiting flap during the approach will be discussed under the non-normal circuits.

***Brakes***
Brakes will need to be used to either slow the aeroplane or bring it to a stop. If carrying out a touch and go, brakes will not be used.

It is very important that you discuss the need for the student to keep their feet off the toe brakes to avoid inadvertent use of the brakes during takeoff or landing.

***Runway Length***
The student should be left in no doubt that sufficient runway length for takeoff and landing must be available before starting the takeoff or approach.

At this point you can tell the student that you have carried out the necessary calculations. However, before the third or fourth (refer CFI) revision exercise of circuits, a formal briefing or discussion of the Group Rating System and its application must be given. Before the fifth or sixth (refer CFI) revision of circuits, the calculation of takeoff distance by reference to the Flight Manual must be carried out.

> The effects of density altitude, weight, surface and slope are discussed during circuit revision when discussing calculation of required takeoff and landing distances. Therefore, they need not be formally introduced in this briefing, unless any are pertinent to your normal circuit (refer CFI). The effect of these factors will be revised (not taught) during the briefing Short Field Takeoffs and Landings.

***Windshear***
The effects of windshear may be discussed in this briefing (refer CFI) or incorporated in the second lesson on circuits.

## Airmanship
Throughout circuit training you should place more and more emphasis on the student's command decision making.

### Checklists
Checklists, as well as the use of a kneepad to record ATIS (Automatic Terminal Information

Service) information, fuel endurance and clearances, will assist in the retention and processing of information.

It is well known that humans are limited in their ability to recall information accurately from memory. The use of written checklists for normal and emergency operations is reasonably common in general aviation. However, basic flight training still tends to use mnemonics exclusively for all operations. What is learnt first is generally accepted as being the correct method, therefore, the use of checklists should be encouraged during basic training.

There are two ways to use a checklist. It can be a list of things to do, as used with complex aeroplanes or systems, or a list to check off things that have been done, as used with simple aeroplanes or systems. General aviation basic training tends to use mnemonics to complete the checks, while confirming that checks have been completed by using a written checklist.

Correct use of the aeroplane radio and checklists will influence situational awareness.

### Right-of-Way Rules

As there will be several preflight briefings during circuit revision, the right-of-way rules can be spread over these briefings.

The suggested rules for discussion in this briefing are:

- aircraft taking off and landing have right of way over all other traffic,
- aircraft landing have right of way over aircraft taking off,
- aircraft established in the circuit have right of way over joining traffic,
- the good aviation practice considerations of avoiding overtaking or cutting in, and
- the application of the right of way rules while taxiing.

The rules or good aviation practice considerations most pertinent to your operation should be considered first, for example, circuit direction and altitude.

## Aeroplane Management

The importance of normal instrument readings is revised.

**SADIE** checks are introduced.

***S*** ***S****uction*
gauge is operating in the green range.

***A*** ***A****mps or* ***A****lternator*
is functioning correctly.

***D*** ***D****irectional Indicator (DI)*
has been synchronised to the compass and is functioning correctly.

***I*** ***I****ce*
existence of carburettor ice has been checked for and the carburettor heat applied if required.

***E*** ***E****ngine*
temperatures and pressures are in the green range.

### Human Factors

Good communication (radio, ATIS), preflight/in-flight planning and regular practise will minimise disorientation. In addition the student should be asked to describe the wind direction and strength to help orientate them.

Visual landing cues should be introduced in this lesson, and the various aspects of visual limitations previously discussed should be revised.

During circuit training there is a possibility the student may reach a learning plateau, where progress may appear to be minimal, discuss this with your student if it happens to them.

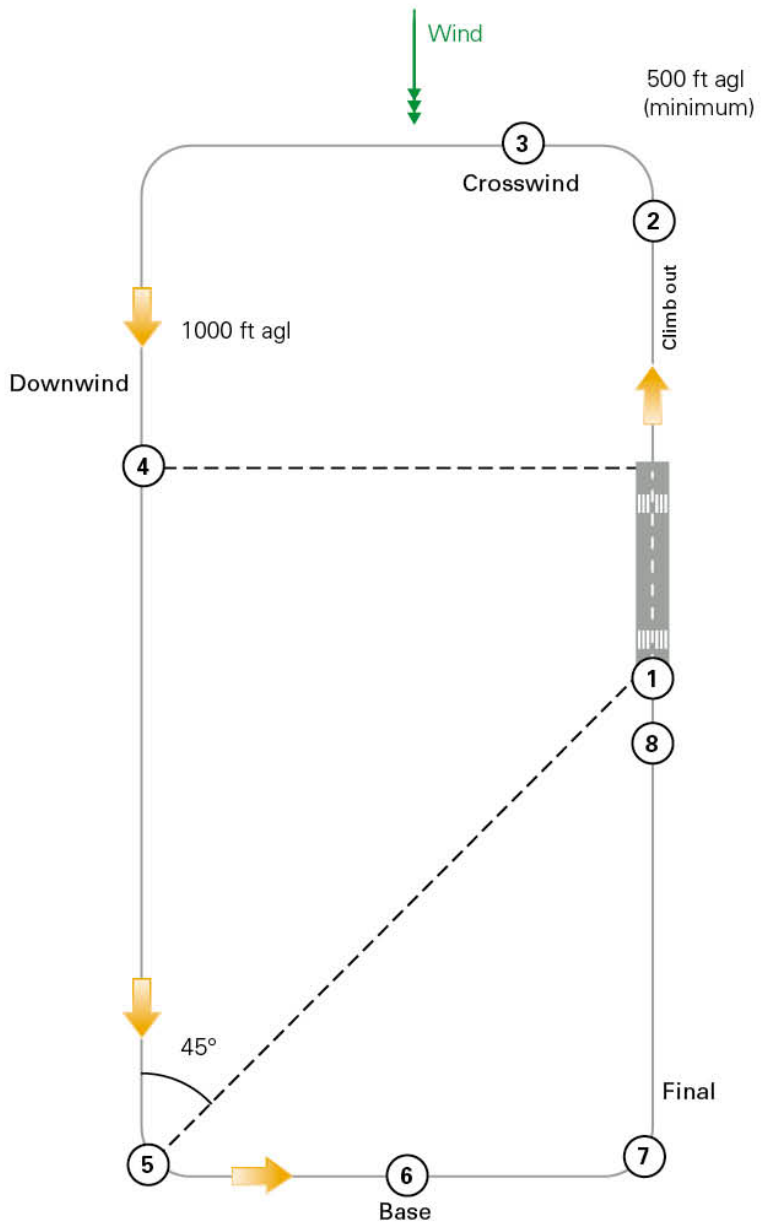
> On the downwind leg, although the physical eye height of students will vary, the effect on the judgement of spacing will be negligible. However, your perspective from the righthand seat may be noticeably different and must be compensated for, as it is what the student sees that is important.

# Air Exercise

One method, you may like to use, is to draw the circuit pattern and number and identify the various points around the circuit at which the listed actions are carried out.

Since each lesson leading up to the circuit involved one or more legs of the circuit, this lesson is primarily revision and application, with emphasis on the new material – the landing.

**Figure 1**



## (1) Takeoff

Only the main points are revised, for example, reference points, keeping straight and rotate speed if applicable, as the student will probably be doing the takeoff by now.

Two reference points should be chosen on lining up (backed up by the DI), one at the far end of the runway on which to keep straight during the takeoff roll, and one higher up to keep straight on during the climb.

This second reference point may need to be modified, if a crosswind is present, to prevent drift and provide a straight track over the ground along the extended centreline.

On lining up, the aeroplane should be allowed to roll forward a short distance on the centreline to ensure the nosewheel is straight and aligned with the centreline.

Once on the runway the aeroplane is held on the foot brakes (if required), never on the park brake. When taxiing, forgetting to release the park brake is easily and rapidly identified, however, with the application of full power for takeoff, the poor acceleration may not be recognised early enough.

> In aeroplanes fitted with only a hand-operated brake, if the brake is applied once on the runway, the hand applying it should not be removed until the brake is released.

Early in the takeoff roll, with full power applied, temperatures, pressures, rpm and airspeed should be checked for normal readings.

During the normal takeoff, the aeroplane is seldom actually rotated. Common practice is to use elevator backpressure to take the weight off the nosewheel as the aeroplane accelerates. The aim is to reduce the loads on the nosewheel (the undercarriage weak link) and reduce friction. As the aeroplane continues to accelerate it will fly off in a slightly nose-high attitude and rapidly accelerate to the nominated climb speed.

'Rotate' generally refers to rotating the aeroplane about its main wheel axles into a nose-high attitude to increase the angle of attack and lift the aeroplane off the ground. Commonly this is done at a speed just above the stall speed (about 5 to 10 knots). The aim of this procedure is to minimise the retarding effects of the ground roll, and is often used on soft surfaces or on runways of minimum length. There may, however, be an appreciable delay in accelerating to climb speed.

Maintain the appropriate pitch attitude until reaching the nominated climb speed, and then hold the climb attitude and trim.

## (2) Climb Out

Each leg of the circuit is named and explained. The first leg – climb out – is the leg on which separation from other aircraft in the circuit is achieved. This is because the aeroplane groundspeed is at a minimum while climbing into wind, and therefore the circuit pattern is minimally distorted. The practice of trying to provide adequate separation from aircraft ahead during the downwind leg, where the groundspeed is at a maximum, should be discouraged as this tends to unnecessarily stretch out a busy circuit. Therefore, although a climbing turn onto crosswind may be started at 500 feet agl, the actual height at which the turn is started will be dictated by traffic ahead.

Where no conflict with traffic ahead is anticipated, the turn should be started at 500 feet agl – this will assist any following aircraft. Ensure an appropriate lookout is conducted, and reference point identified.

During the climb out and at a safe height, not less than 300 feet agl, the after takeoff checks are completed. A check is made (glance back) to confirm whether the chosen high reference point is maintaining the aeroplane along the extended centreline. If not, an adjustment to the chosen reference point is made.

> If flap is used, retraction heights and speeds need to be discussed.
>
> At night runway heading (DI) is maintained to avoid spatial disorientation.

## (3) Crosswind

The crosswind leg is at 90 degrees to the climb out path and in the circuit direction. Before starting the turn, lookout is stressed and a reference point onto which to turn is chosen.

Commonly, this is a point on the horizon off the wingtip. However, since the aim is to track over the ground at right angles to the runway, the reference point will need to be modified to allow for drift.

## (4) Downwind

For many situations the turn onto downwind is made when the aeroplane is at 45 degrees to the upwind threshold, onto a suitable reference point so as to track parallel to the runway, and the aeroplane is levelled at circuit altitude. This may require the aeroplane to be levelled before, during or after the turn onto downwind. Lookout is again stressed, especially for aircraft joining the circuit on the downwind leg.

The downwind radio call is given abeam the upwind end of the runway to positively establish your position in the circuit for other traffic and Air Traffic Control (ATC) if applicable. If the radio call is delayed for any reason until abeam the threshold, or later, the call should be "late downwind."
As a common courtesy, and to promote situational awareness for all traffic in the circuit, the downwind call should include your intentions, for example, full stop or touch and go. If your position in the circuit is advised by ATC, for example, "number three", a visual search must be made to positively identify the positions of the appropriate number of aircraft ahead. This is generally achieved by scanning from the threshold back along the approach path and base leg, counting off aircraft sighted, ahead of you.

### *Checklists*

The attempt to standardise checklists across aeroplane types may result in irrelevant checks becoming so automatic that they are not actually carried out when required. Latent errors do exist within checklists, and it is recommended that the normal checklist be type specific and backed up by a written checklist (refer CFI).

Thus the use of BUMFH is considered irrelevant for fixed-undercarriage types and generally wrong for retractable types. Most aeroplanes with retractable gear require the undercarriage to be extended before the brakes can be checked for pressure. So the mnemonic should be UBMFH when flying aeroplanes with retractable undercarriage.

The prelanding checks are completed.

***U*** ***U**ndercarriage*
Down and locked (If your organisation includes it at this stage for consistency with later training.)

***B*** ***B**rakes*
Pressure checked, and park brake off

***M*** ***M**ixture*
RICH

***F*** ***F**uel*
On the fullest tank, fuel pump ON and pressure checked

***H*** ***H**arnesses and Hatches*
Secure and doors or canopy closed

### *Spacing*

To judge spacing, a feature of the airframe is assessed against the runway; for example, in most low-wing aeroplanes the correct spacing is achieved when the wingtip runs down the centreline, as observed by the student. In the PA 38, which has very long wings, the outboard flow strip is used, and in high wing aeroplanes the spacing is normally one third of the way down the wing strut from the tie-down end. This can be difficult for the student to see, and there may be some value in marking the strut with tape or a felt-tip pen at the approximate position on the strut through which the runway should cut.

The spacing should be assessed and then corrected at the base turn, allowing for any drift. Do not weave downwind in an effort to correct the spacing. The reference point may be altered in order to maintain a parallel track to the runway. In nil wind the DI should show the reciprocal of the runway in use.

## (5) Base Turn

The turn onto base starts at approximately 45 degrees to the threshold. Emphasise the lookout and choose a reference point off the wingtip. Carburettor heat is selected ON, power reduced and a level turn started to bring the airspeed into the white arc. Once in the white arc, 10–20 degrees of flap is selected and, as the airspeed approaches the nominated descent speed, the correct descent attitude is selected, held and trimmed.

The power setting chosen at the base turn depends on the assessment of the downwind spacing (close, correct or wide) and the proximity to 45 degrees from the threshold when starting the turn (early, correct, late). Commonly, 1500 rpm is used as a guide, and this is based on the correct spacing downwind and 45 degrees to the threshold. Any other condition will require a higher or lower power setting; for example, close downwind but correct at 45 degrees, try a lower power setting, say 1300 rpm.

The turn is continued onto the reference point with an allowance for drift or until the leading edge of the wing or wing strut is parallel with the runway (allowing for drift).

> Avoid using ground features as turning reference points as this may cause difficulty for the student at an unfamiliar aerodrome.

## (6) Base Leg

Once established on base leg additional flap is extended and the attitude adjusted to maintain the nominated approach airspeed.

At the base turn, the student should be encouraged to estimate what power setting they would require, to take them to the threshold in a steady descent without any changes. This does not mean that the power setting should not be altered if required.

Before the descending turn onto final, emphasise the lookout, especially along the approach path to ensure no other aircraft are on long final.

The roll out onto final, or approach leg, must be anticipated so that the wings are level at the same time as the aeroplane is aligned with the centreline. Throughout the turn the angle of bank should be adjusted to achieve this by about 500 feet agl. The nominated approach airspeed should be maintained by adjusting attitude.

During the approach, as with all phases of flight where the intent is to maintain a specific airspeed, it is important to emphasise that the correct attitude, for the desired airspeed, should be selected, held and trimmed.

**Attitude controls the airspeed**

## (7) Final

When established on final, full flap is selected at the appropriate time and the airspeed maintained, or allowed to decrease to threshold crossing airspeed through attitude adjustment (refer Flight Manual and CFI).

Because of the possibility of large flap deflections and the aeroplane's low altitude, extending flap during the turn onto final is avoided.

The approach path is monitored by reference to the correct runway perspective. Throughout the descent the aiming point, commonly the runway numbers or threshold, is monitored and the power adjusted as required to maintain a steady rate of descent to touchdown.

**Power controls the rate of descent**

With the aeroplane trimmed to maintain the required attitude (airspeed), if the aiming point moves up the windscreen, the aeroplane is undershooting – increase power. If the aim point moves down the windscreen, the aeroplane is overshooting – decrease power. If the aeroplane is correctly trimmed the power adjustments will be quite small; these are often described by the term "a trickle of power."

On short final in anticipation of any requirement for full power, carburettor heat is selected COLD when a landing is assured.

### 8 Landing

The landing is one smooth manoeuvre designed to slow the rate of descent to zero and the speed to just above the stall speed, as the wheels touch the ground. This manoeuvre consists of two phases, the round-out and the hold-off, also known as the flare. This is essentially a progressive transition from a descent into a flared landing attitude, similar to a power off stall, with touchdown just before the moment of stall.

The round-out begins at a suitable altitude for the aeroplane's speed. For a normal approach this is described as about 50 feet.

When the landing is assured, often pattered as "crossing the fence", the throttle is closed, and at about 50 feet the nose attitude progressively raised – the round-out. As the airspeed decreases the aeroplane will start to sink. The sink is observed by looking outside at the far end of the runway (or horizon) and this is the point where the second phase of the landing process begins. The most common errors made by students during the round-out is not looking far enough ahead and lowering the nose in an attempt to fly down to the ground.

The hold-off involves a gradual increase in backpressure to control the rate of sink and to achieve the correct attitude so that the touchdown is light and on the main wheels only. During this phase the student's focus is gradually shortened to facilitate depth perception and provide cues about the sink rate until, at touchdown, the point of focus is just ahead and slightly left of the aeroplane's nose.

Following touchdown on the main wheels, the nosewheel should be gently lowered with elevator by relaxing the backpressure and lowering the nose onto the runway.

Keep straight on the runway centreline with rudder by reference to a point at the far end of the runway, and apply brakes as required.

Under ideal conditions, during the student's introduction to the circuit, each circuit is flown to a full stop and the aeroplane taxied to the holding point for another takeoff. Therefore, the considerations of a touch and go and the go around are deferred to the next circuit lesson – *Circuit Considerations*.

Although including the go around in this briefing can generally be deferred, it is not always convenient in a busy circuit to carry out full stop landings. Therefore, a brief discussion on the touch and go procedure may need to be included in this briefing (refer CFI).

Should a go around be required during this introductory exercise, it is recommended that you take control and patter the procedure.

The after landing checks are normally completed clear of the runway.

## Air Exercise

### On the Ground

The student should be capable of taxiing to the appropriate holding point and carrying out at least some of the checks and using the checklist. Complete the takeoff safety (or emergency) brief for the student, inform them that you will cover this in a future lesson, and then you will be asking them to do their own.

### The Exercise

Start by giving a demonstration of an ideal circuit, followed by pattering the student through a circuit.

The student should be able to fly almost all of this exercise, but will probably still need help with the landing. Let them fly as much as possible – they will only learn by doing, and they need to be doing it consistently for themselves before they can go solo.

You will need to talk them through most of this exercise, but as the circuit lessons progress you will find yourself saying less and less.

## After Flight

Reassure the student that even though there seems to be a lot to fit into the circuit there will be plenty of opportunities to get it right, as all of the following lessons to first solo will be in the circuit.

Encourage them to continue learning the ground checks, and to start learning the prelanding checks.

> During circuit revision, your supervisor will regularly fly with your student, to monitor the student's progress and provide feedback on your instruction. This does not prevent you from carrying out a briefing or discussion before the revision flight, on any of the subjects to be covered before first solo.
>
> Throughout circuit revision, formal briefings or guided discussions will be required to ensure that all environmental factors affecting taxiing and the circuit have been learnt by the student before presenting the student to your supervisor for a pre-solo check flight.
>
> Remember to check English language requirements are met well before first solo is considered.