The Honourable Company

of Air Pilots

(incorporating Air Navigators)

TEACHING FORCED LANDINGS

A GUIDE FOR INSTRUCTORS

Teaching Forced Landings – A Guide for Instructors

Foreword

This document has been produced to provide instructors with a guide which they can use to teach a practical method of dealing with a situation requiring a forced landing without power. As with other general guides, it is impossible to say that the technique described in this guide can be followed exactly for every aircraft or situation encountered. However, although variations in aircraft type and equipment fit may require some modifications to the technique described in the following paragraphs, this document provides a general framework encompassing what is believed to be best practice in meeting the PART-FCL syllabus requirements for teaching the forced landing routine (Exercise 16).

Introduction

During the early days of flight it was not uncommon for a forced landing to result from engine or airframe malfunction. The reliability of modern aircraft has made such a forced landing a rare event. However, human factors always provide opportunities for aircraft systems (especially the fuel system) to be mismanaged, which means that forced landings continue to occur.

Whatever the cause, pilots need to be trained to react to an engine loss of power by following a set of procedures in a sequential manner to achieve a safe outcome. In addition, instructors should instil the skills required to prevent an engine failure. Students should be encouraged to develop a comprehensive understanding of aircraft systems and fuel consumption, and above all must correctly plan every flight. If pilots employ good operating practices, a forced landing without power will be a very rare, probably never experienced, event.

Forced landing practice must never be allowed to become an academic exercise carried out just to satisfy a syllabus. It must be treated as an exercise in survival, in which positive thinking is backed up by good judgement. Confidence and competence must be developed if the exercise is to be of real value. Because this is very much a judgement exercise, and solid learning results from making, considering and rectifying mistakes, it is vital that criticism of errors should be positive, and students (and pilots) are encouraged to use an instructor's knowledge and skill to stretch their own ability.

Good instruction requires that the exercise should be first demonstrated along the lines of the ideal forced landing situation. This should give the instructor time to teach, and the student to comprehend, the various component parts of the procedure. Once the student has grasped the principles and procedures required, then variations to the basic procedure can be introduced. Development of competence will only come from frequent practice during training, followed by recurrent training and practice to retain the required level of skill after qualification.

Briefings

The Long Briefing should prepare the student for the exercise and allow time for the information to be absorbed before the flight itself. It should cover:

1. Objectives and reasons for the procedure.
2. Procedures including – choice of landing area, provision for change of plan and gliding distance considerations.
3. Descent plan including – key positions, checks, restart drills, use of radio and securing the engine.
4. The base leg, final approach and landing.
5. Actions after landing including aircraft security and passenger welfare.
6. Threat and Error Management, including common errors.

The Pre-flight brief should focus on the handling of the aircraft and management of the procedure.

When may a forced landing be required?

A number of scenarios may lead to the need to carry out a forced landing, such as an engine failure, deteriorating weather, a developing structural failure, or control problems.

Precautionary landings with full power available are the subject of Exercise 17. Exercise 16 involves dealing with an engine failure and is the subject of this guide.

Planning the work cycle

The aim of the exercise is to achieve a safe landing from which all on board can walk away. Attempting to avoid or minimise aircraft damage can often conflict with that requirement, and the priority must be emphasised at all times during the exercise. A pilot faced with the need to carry out a forced landing should endeavour to follow a structured approach to the actions required to achieve that safe landing.

The more height available at the time of the failure, the more time will be available for setting up for what hopefully will be a successful forced landing. The average light aircraft has a rate of descent of around 800 feet per minute in the glide, so if the procedure can start at 2500 ft above ground, around 3 minutes is available to set up and execute the landing. That timing assumes a fair degree of promptness and accuracy in achieving and maintaining the glide. Students and pilots out of current practice may not achieve this performance to start with so the descent time would no doubt be less than 3 minutes, compressing the time available to carry out the actions required.

The old aviation adage of Aviate, Navigate, Communicate can be applied to the actions required following a loss of power, with each topic amplified to cover the requirements of the procedure.

The engine has stopped!!!

Having got over the initial shock of the lack of power, and engine noise, the first priority is to ‘Fly the Aircraft’. Having practised the drills for engine failure after take-off, the student should be able to recognise a power reduction, or at least adjust the attitude to promptly achieve best glide speed, and trim to it. During the speed reduction, any temptation to start manoeuvring must be resisted. Excess speed may be converted to height; a smooth pitch up from 90 knots whilst slowing to 70 may gain a couple of hundred feet on a good day.

This can be coupled, if appropriate, with applying Carburettor Heat to soak up any residual heat in the system and to cut off the cold air to give carburettor temperature a chance of melting the ice that may have been the cause of the stoppage. For teaching purposes, when simulating the failure by closing the throttle, if the student does not apply carburettor heat, do so yourself (However, a judicious warming shortly beforehand reduces the risk of a real failure). Be prepared to make the selection if the student is slow to react.

Another immediate consideration is the terrain below. It may be better to instigate a turn to flatter/lower terrain rather than pick an area in your immediate vicinity. There will not be a lot of time to consider this, but a manoeuvre at this point may provide a better ending. Because UK airspace and weather often prevents cruising above 2,500 ft agl, a turn to a downwind heading may improve your chances of finding a suitable landing area and in fact may be the best option as there may be insufficient time to make a complete circuit of the eventually chosen field. However, the landing itself must be into (or mainly into) wind

Any passenger(s) will be aware that something out of the ordinary is occurring. The pilot should take a few seconds to give reassurance and a brief description of what’s happening. A more detailed brief for landing can be given later, once the appropriate course of action is established.

Where are we going to land?

A number of items should be considered when selecting a suitable field or landing area. Use some of the time in transit from base to the training area to give the student guidance on what to look for. Looking ahead and left will give the best view of a possible field, but point out that the best field may be to the right or behind.

Depending on the terrain it may be possible just to pick one field although it is preferable to pick a series of fields so that there are undershoot and overshoot options available. If a suitable field or fields are few and far between it may be necessary to select an ‘open area’ with the expectation that some damage to the aircraft will occur. The cabin is designed to absorb a lot of that damage, so the occupants should escape with little or no injury provided the aircraft lands into wind. Even a controlled crash is much safer than stalling in from height.

For training purposes, it is important that both instructor and student are aiming for the same field. Especially for early practices, it is probably worth agreeing on the target field before closing the throttle.

A common error is to assume that the figure shown on the altimeter is the height above ground. The altimeter will probably be set to QNH so it will be indicating altitude above sea level. If you know or can check the elevation of the terrain underneath you can cross check with the altimeter to determine actual height available for the glide and landing. Better still, build the ability to judge glide positioning by eye and don't worry too much about what is shown on the altimeter!

Wind direction: Use local features as a guide to direction, e.g. smoke, dust, wind lanes on water. In the absence of local features - wind on departure from the airfield or forecast wind from the Form 214 are fall backs. Preflight planning should always include emphasis on the en-route wind gradient.

Size/Shape: The bigger the better. Long and thin is usually better than short and fat. The longer direction should be into wind. Consider using a diagonal run across a field to increase landing distance

Slope: Ideally a fairly flat field would be first choice. Should the choice(s) be limited to sloping fields then wherever possible take the uphill slope. Beware, slopes can look quite shallow from 2,000 ft or so, do not attempt to land across any that are visible from that height. Remember, rivers follow the lowest ground.

Surface: Colour and texture should give clues as to what the ground is made up of. Be aware that low ridges and furrows don't always show up from a couple of thousand feet. The pilot may be taken by surprise during the later stages of the approach when a ridge or depression appears in a field.

Pasture (usually light green in colour) or stubble are usually the first choice of surface, although brown (harrowed not ploughed) fields should not be ignored. If a private airstrip is conveniently placed and looks long enough then go for that. Dark green usually represents a crop, the height of which will have an impact on how quickly the aircraft comes to a stop. Brown is often ploughed earth which may be significantly ridged. Dark green and brown surfaces are best avoided if flying a nosewheel aircraft.

Obstructions: The countryside is full of things that can bring an aeroplane to a sudden stop. Some, such as trees, pylons, or buildings, are easy to see whilst fences, ditches, low slung wires, and even animals may not be readily identifiable until quite close. Needless to say we don't want obstructions on the approach or at the upwind end which may cause a problem if the glide is misjudged. So look carefully as you descend. When practising, the go-around area must also be clear of obstructions.

Sun: Glare from a low sun can make it very difficult to judge height. Avoid an approach directly into sun if possible.

Access: Relatively easy access to the chosen field will help rescue and retrieval. However, time considering access would be better spent concentrating on a safe pattern.

Plan the descent

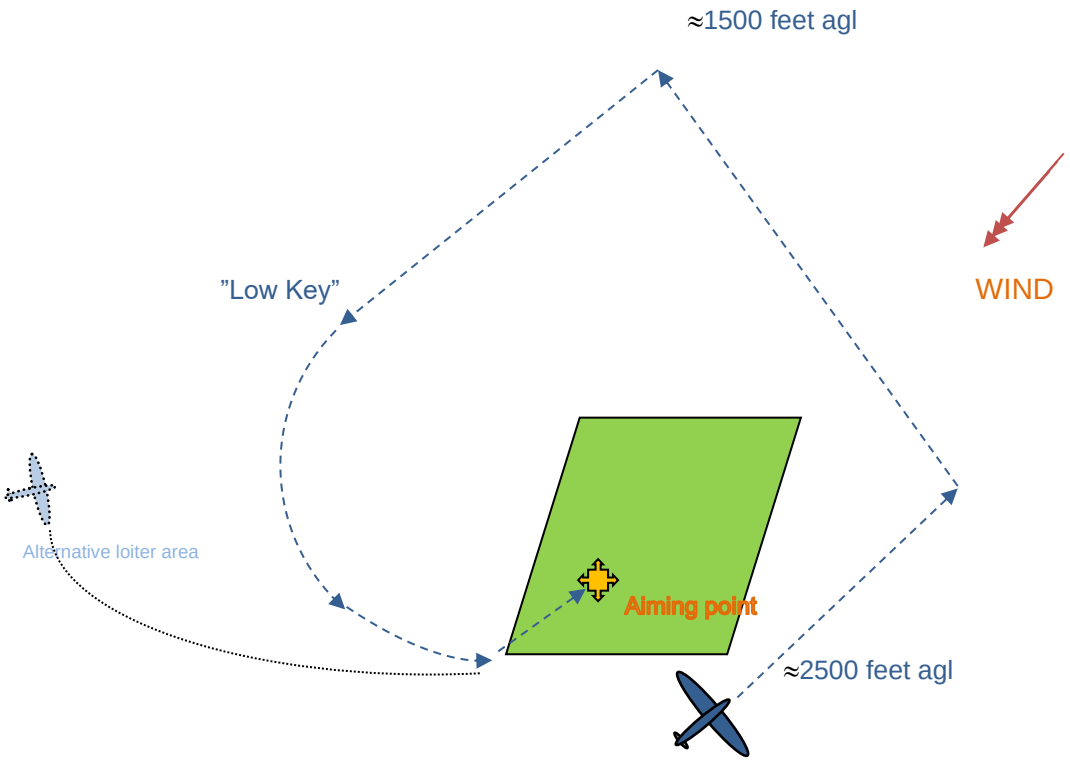
In an ideal world the pilot would fly a left hand circuit to put the field on the pilot's side. However, the world is not always ideal. There may be a need to fly a right hand circuit or even an abbreviated circuit. Height and distance from the chosen field will dictate the best option. Above all, the pilot must not lose sight of the chosen field as he or she manoeuvres around it. The instructor of course will find that difficult, so consider using areas and fields which are known to you, or at least easy to identify after losing sight of them.

If power has not completely failed, there may be a temptation to attempt to keep the aircraft flying towards an aerodrome or even return to base. That should be resisted. By all means use any residual power to improve the chance of a successful landing, but once an ideal pattern has been achieved it is better to close the throttle completely (or switch off the engine) and concentrate on that pattern than to fly a wider pattern and risk a total failure at an embarrassing distance from the field.

When planning the descent initially plan to land long in the field. Choose an aiming point about a third of the way in. As the circuit around the field progresses, the pilot can adjust the final approach track and use flap to achieve the final desired touchdown point.

Ideally, the aircraft should fly a pattern at glide speed around the chosen field similar to that shown in the figure to give the pilot an opportunity to spot obstructions and simplify judgement during the descent to land. Initially plan to land at your aiming point. Drift needs to be monitored to ensure that the wind does not push the aircraft too far away from the chosen field.

From "Low Key" onwards the aircraft is following the standard 'glide circuit' pattern, adjusting track to maintain a constant 'sight line angle' to the aiming point. An aiming point about a third of the way into the field will allow for errors and use of full flap on final approach. However, height is often insufficient to follow the ideal pattern completely; in that case try to follow as much of the pattern as possible through Low Key, or manoeuvre in the area of the start of a glide circuit base leg until you judge height is correct for the final approach.



Forced landing pattern

Manoeuvre as required to achieve a safe approach into the chosen field, but always try to keep the field in view. Turning away from an unfamiliar target may make it difficult or even impossible to spot again once heading (apparently) towards it. If you must turn away, spend a few seconds noting identification features beforehand.

What's wrong, can we fix it?

Once the pilot is sure the pattern can be achieved, or has been started, the failure checklist can be employed. This will vary with aircraft type, so consult the POH for details. Consider a 'flow' that sweeps the cockpit in a straight forward manner that picks up the items from the checklist. During practices, encourage the use of 'touch drills'.

In a circumstance where the checks don't reveal an obvious failure cause it may be worth trying to restart. Consider what the engine is actually doing at this moment.

Is the propeller rotating or not? If it is then it's probably fuel or ignition. Except in the very rare case of a major magneto failure it'll probably be a fuel problem. So, after selecting an alternative fuel source, reset the throttle to, say ½ inch and see if any power is restored. If nothing changes after a few seconds then you're committed to a forced landing.

Bear in mind that for most aircraft with direct drive propellers the aircraft will need to be flown almost down to stalling speed before the propeller stops turning. If the propeller has stopped by the time glide speed is established, something nasty has happened inside the engine and a restart attempt is unlikely to help.

Radio

All of the above will have consumed several hundred feet of altitude as you fly towards or around the pattern. Now is probably the time to make the Distress call. Don't be embarrassed about using the word 'Mayday' if the engine has failed, and don't spend time worrying about the format. Try to introduce a 'Practice Pan' call at least once during training.

It may, especially if over hilly terrain or over water some distance from the coast, be a good idea to make the call earlier. But priority should always be given to flying the aircraft, and normally to finding a landing site and setting up the pattern first. Set the transponder to 7700 when appropriate.

Secure the aircraft for landing

Refer to the check list and/or POH for the items that need to be covered. Don't forget that passengers need to be suitably briefed on what is happening and precautions to be adopted for landing.

Final Glide

Assuming the pilot is well practised at glide approaches in the circuit, and the low key point is sensibly chosen, the approach from base leg to touch down should work out with little drama.

Instructors should use glide circuits to ensure that their students have a skill set that will enable a good approach to be flown. They must be able to judge the approach path and control it by use of flap, sideslip or S turns. However, approach judgement becomes almost impossible if the aeroplane speed is fluctuating. Too fast and the aircraft may float across the chosen field and either land in the far hedge or continue into the next field. Too slow and the aircraft may land short or, worse, stall on the approach. In the real case, adrenaline, panic or fear are likely to impair a pilot's judgement and lead to errors, so confidence resulting from frequent successful practices is important.

Unlike the glide circuit practised to a runway, the touchdown point in a field can be adjusted by changing the orientation of the base leg and final approach direction. The student must be given practice at this technique.

Accident reports frequently describe forced landings where the aircraft suffer damage on landing. A common reason is manoeuvring late on the approach, allowing the speed to decay and produce a high rate of descent which cannot be arrested before the ground intervenes. More serious accidents result from the aircraft being allowed to stall or even start to spin with insufficient height to recover.

When practising manoeuvres to adjust the approach path, the instructor should emphasise speed control (trim and relax!) to ensure predictable performance and an adequate margin above the stall. If it is obvious that the aeroplane cannot be flown to the aiming point then an alternative landing area needs to be chosen, preferably one already considered. If full flap has been selected to land between the hedge and the aiming point, it may be possible to regain a little performance by removing the full flap, but never raise the flap which provides essential lift. The effect of this, and that of stretching the glide, should have been demonstrated during the pre-solo exercises, but further demonstrations of both – at a safe altitude – should be considered.

If, just before touchdown, a fence or other obstruction becomes visible, the pilot should not make large or sudden changes to the flight path. Losing control in the air or on landing is likely to cause much more damage than hitting an obstacle.

After landing

Although it should not be necessary to practise the actions after landing, the long briefing should include the actions after the aircraft has been brought to a halt. Despite a pilot's best endeavours, the possibility of injury or serious damage cannot be totally discounted, so consider how to abandon the aircraft on the ground. Otherwise, the aircraft should be shut down in accordance with the POH. In any case, the occupants should be evacuated without delay to a point upwind of the aircraft with any necessary warm clothing. Attempt to contact ATC, flying club, next of kin and other interested parties to let them know all's well.

The land owner will need to be informed. Aircraft insurance will usually cover any third party claim, but contact the insurance company before moving the aircraft. If you can, keep cows away; they like cellulose dope and paint!

The aircraft will be retrieved by whatever means are considered appropriate. An easy repair and a large field may well allow the aeroplane to be flown out. Otherwise the engineers will have to dismantle the aircraft and put it on a lorry.

Threat and Error Management

During forced landings, the threats and errors faced by a pilot are not fundamentally different from other phases of flight, but the stress inevitably involved makes sensible management of them vital. Practices add further threats and errors of their own which also demand the pilot's (usually the instructor's) attention.

Speed Control

With a lot to think about and unyielding time pressure, it is easy to lose focus on speed, and even to miss a stall warning. Emphasis the need to maintain correct airspeed during all phases of flight, and ensure the aircraft is flown in trim. The potential consequence of poor speed control is a stall/ spin event which may well be fatal.

EXTRA CONSIDERATIONS WHEN PRACTISING

Engine Handling

Our antique, air cooled engines do what they say on the tin, but need to be warm and available to go-around. Equally, antique carburettors are vulnerable to icing when the throttle is closed. If the engine is not looked after correctly a practice can become a real engine failure. Ensure survival by warming the engine occasionally and being punctilious with carburettor heat operation

Wires.

Power cables can reach considerable heights and interfere with your approach and/or climb out.

Low flying aircraft.

Beware military aircraft which often fly at 500 feet or below. Farmers' strips and microlight fields may not be either obvious nor marked on charts, and aircraft may be approaching or departing from them

Noise

Noise/ low flying complaints are unpleasant and can ultimately be expensive to deal with. Panicked animals can injure themselves, and also people near them, even though there is no hazard to the pilot. Manage the exercise by taking care with what you are over flying & anticipate the go-around flight path. Increase power gently and progressively. Don't use practice landing areas twice on the same flight. Strive to obey the low flying rules.

Going around

Normal go-around technique should be adopted. Ensure that flap retraction is carried out correctly and at the right speed. Watch for early flap retraction which may lead to a high rate of descent and a possible stall/spin developing.

The Air Exercise

Instructors should not overwhelm their students with all the information at once. The initial teaching and practices should concentrate on handling and the ideal pattern. Emergency drills and radio calls are important but should only be introduced once the basics have been learnt and demonstrated.

During the teaching of the air exercise instructors should take full responsibility for the necessary safety aspects, including lookout, ATC liaison, carburettor heat operation, engine warming and minimum height, although they should ensure they are covered during briefing and debriefing. These aspects should be formally taught and the student must be competent in them, before any solo engine failure simulations.

After the initial teaching and practices, the instructor should instigate further practices by describing symptoms of engine failures. Describing symptoms of incipient failures gives time to warm the carburettor if appropriate and encourages familiarity with emergency drills.

For discussion during the briefing:

Following failure of the engine there may be little or no propeller slipstream passing over the elevator, thus it will be less effective than the pilot may be used to. This can become evident in the round out as it is discovered that the elevator requires more control column movement, and more time, to change the attitude. For this reason the threshold speed may have to be higher (5 knots?) than for a normal approach.

A windmilling propeller will generate more drag and increase the rate of descent, maybe by 200 – 300 ft/min compared to the descent achieved during a practice with an idling propeller. Adjusting the angle of bank to maintain a constant approach slope should avoid this becoming a problem.

De-briefing points:

As with any lesson there should be a post flight review of the exercise flown. The review should cover:

1. A recap of the exercise stressing the importance of:
    a. The importance of achieving the correct glide speed.
    b. Proper planning of the descent.
    c. Following the ideal procedure as closely as possible.
2. Discuss the common faults usually made
    a. Forced landing poorly planned
    b. Even experienced pilots can be stressed into mistakes.
    c. Losing sight of the selected field during descent
    d. Landing downwind
3. Discuss the actual faults noted during the exercise, cover symptoms of the fault, cause, result and corrective action required.

And finally ….

A reminder that light aircraft are reliable. An engine failure is a rare event but the possibility should not be overlooked. Therefore, in addition to careful monitoring of engine instruments and noises, regular practice of the forced landing procedure will help to keep a disciplined approach to the checks, drills and procedures required. Recalling procedures can be extremely difficult when faced with the stress of a real emergency.

Aim: To learn how to plan, fly an approach and to land safely in the event of a complete engine failure.

Threat Error Management:

Threat	Consequence	Mitigation
Engine failure	Forced landing	Correct drills/choice of landing area
Too high in pattern	Overshoot landing area	Technique
Low flying military	Collision/wake turbulence	Lookout

PRE FLIGHT:

- Pre-flight brief with Forced Landings Without Power (Ex16) as main exercise
- Weather and NOTAM brief
- **Student to practise:** Preflight checks with emphasis on engine performance. Other items as seen appropriate from the overview.

AIREX:

- Short field take-off over 50ft obstacle
- During transit to training area at low-level (≤1000' AGL) teach field selection
- Revise climbing at best angle
- **insert emergency relevant to the flight**

- Further student practise of full procedure..
- **Recovery to base student to practise:** Use of VDF DF and items as seen appropriate from the overview but to include either :
  a. Overhead join PFL from overhead if traffic permits
  or:
  b. Glide approach & landing

POST FLIGHT & DEBRIEF:

As previous

Ref: AMC1 FCL.210.A (c) 2 xx Ex16

This exercise in managing an engine failure at altitude requires the student to consider the time available and prioritise actions requires. Suitable planning and executing appropriate checklists are essential. Practice in different locations and wind conditions will be required however good skill and accuracy must, therefore, be evident before the next lesson.

NB – Mark as satisfactory √ or X as applicable.

If 'X' annotate 'Omitted/Re-teach/Revise' – delete as applicable.

The student demonstrates a clear understanding of the principles of:

- ☐ Suitable field selection Omitted / Re-teach / Revise
- ☐ Planning Omitted / Re-teach / Revise

The student demonstrates correct use of the requisite techniques of

- ☐ Executing a planned approach Omitted / Re-teach / Revise
- ☐ Perform relevant checklists Omitted / Re-teach / Revise
- ☐ Making a Distress R/T call Omitted / Re-teach / Revise

Comment on all items annotated "X" above

General remarks and notes:

LESSON 21– EXERCISE 16 FORCED LANDINGS WITHOUT POWER

DURATION 1.00

Aim: To learn to plan, fly an approach and to land safely in the event of a complete or partial engine failure.

Threat Error Management:

Threat	Consequence	Mitigation
Carburettor icing	Power loss	Use of carburettor heat
Real engine failure	Actual forced landing	Engine warm (500' Cx) Suitable landing areas
Low flying military	Collision	Lookout

PRE FLIGHT:

- Pre-flight brief with Forced Landing Without Power and partial engine failure (Ex16) as main exercise.
- Weather and NOTAM brief
- **Student to practise:** Items as seen appropriate from the overview but including short field take-off performance

AIREX:

Student practise - Take-off (soft field?), climb, transit to suitable area

FLWOPs:

- Student practise – PFL (total failure) from a suitable altitude (3000' AGL).
- Teach adjustment to procedure for failure at a lower altitude (2000')
- Student practise.
- Teach further adjustments to procedure for failure at 1000' AGL
- Student practise from different starting altitudes and locations.
- Teach actions in the event of partial engine failure.
- Student practise actions in the event of a partial engine failure

- **Recovery to base student to practise:** Items as seen appropriate from the overview but to include either:

c. Overhead join and PFL from overhead if traffic permits

or:

d. Simulated engine failure downwind, glide approach & landing

POST FLIGHT & DEBRIEF:

As previous

Ref: AMC1 FCL.210.A (c) 2 xx Ex16

This exercise in managing an engine failure at low altitude requires the student to consider the time available and prioritise actions requires. Suitable planning and executing appropriate checklists are essential. Practice in different locations and wind conditions will be required however good skill and decision making must, therefore, be evident before the next lesson.

NB – Mark as satisfactory √ or X as applicable.

If 'X' annotate 'Omitted/Re-teach/Revise' – delete as applicable.

The student demonstrates a clear understanding of the principles of:

- ☐ Suitable field selection — Omitted / Re-teach / Revise
- ☐ Planning — Omitted / Re-teach / Revise

The student demonstrates the correct use of the requisite techniques of

- ☐ Executing a planned approach — Omitted / Re-teach / Revise
- ☐ Performing relevant checks — Omitted / Re-teach / Revise
- ☐ Making a Distress R/T call — Omitted / Re-teach / Revise
- ☐ Passenger briefing — Omitted / Re-teach / Revise

Comment on all items annotated "X" above

General remarks and notes: