HANDLINGSENSE LEAFLET 1
TWIN PISTON AEROPLANES

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1 INTRODUCTION

a) The major difference between operating multi-engine piston (MEP) and single-engine piston (SEP) aeroplanes is in knowing how to manage the flight after the failure of an engine. Although having more than one engine gives the pilot more options, in practice the number of ***safe*** options is limited, either by control or performance.

b) The aim of this leaflet is to remind pilots of MEP aeroplanes of some of the basic handling considerations, and to offer safety guidance on the options available in the event of an engine failure. Only an overview can be offered here; there are a number of books available offering more detailed information (see LASORS list of recommended reading).

2 PERFORMANCE

a) Climb performance depends on the excess of power available over that required for level flight. Failure of one engine obviously results in the loss of half the total power available. However, most of the remaining power is used to overcome drag so that typically the “excess” power left for climbing will be reduced by 80% to 90% depending on ambient temperature, altitude and aeroplane mass.

b) Most MEP aeroplanes used for training, air taxi operations and general aviation were designed and built by Piper, Cessna, Beechcraft and Grumman to Federal Aviation Regulations part 23. For certification under these regulations, MEP aeroplanes that weigh 6000 pounds or less and have a stall speed of 61 knots or less do not need to demonstrate any single-engine climb performance at all! The single-engine climb performance required for certification of MEP aeroplanes that are heavier or have higher stalling speeds must be positive but is still very low (a Cessna 310 for example must demonstrate only 110 feet/minute).

c) On most MEP aeroplanes there is usually no provision for single-engine climb performance until the aeroplane is configured correctly (e.g. landing gear and flap retracted, full power on the live engine, propeller feathered on the failed engine, single engine best rate of climb speed Vyse). The act of raising the gear or retracting the flap may, in some aeroplanes, cause a temporary increase in drag, loss of lift or even reduction in control margin. Thus, from the time of engine failure on take-off to achieving the single-engine climb criteria, a forced landing must be considered as a likely outcome.

3 ENGINE FAILURE DURING TAKE-OFF

The options available to a pilot when faced with an engine failure during take-off depend on the stage of flight:

a) **Rejected Take-off**. During the take-off run, loss of an engine will result in loss of directional control. At low speeds the rudder is less effective and the best method of regaining directional control is to close both throttles and use rudder and asymmetric braking to keep straight. The accelerate/stop performance figures, if available, will indicate whether a high speed rejected take-off is possible on the runway in use.

b) **Land back on the remaining runway**. In the event of an engine failure just after take-off (say 50'), the safest option is normally to close both throttles and land back on the remaining runway. On a long runway, consideration should be given to delaying gear retraction whilst landing-on remains an option. It is unlikely that performance figures are available for this manoeuvre, but as a guide the sum of take-off distance and landing distance, plus an allowance for reaction time (say 500 feet?) will give a fair approximation.

c) **Forced Landing**. As discussed in paragraph 2 above, an engine failure after take-off but before achieving the single-engine climb criteria may be controllable but offer no climb performance. It is very difficult to lay down hard-and-fast rules on the best course of action, as this will depend very much on individual circumstances. However, there will be occasions when it is safer to use the available power to make a controlled landing in a suitable area, rather than attempt to climb away. Local knowledge of suitable landing areas is beneficial. As a guide, Vyse will give best performance, which in this case might be minimum rate of descent.

d) **Continued Climb**. If, having completed the EFATO immediate action drills, a climb can be achieved at Vyse then it should be possible to continue flight to land back at the aerodrome. Remember that 5° of bank towards the live engine will minimise drag and increase climb performance. Turns should not be attempted before reaching a safe height, bearing in mind that turns will reduce climb performance. Complete any subsequent actions when the aeroplane is under control and trimmed.

4 EFATO – IDENTIFYING FAILED ENGINE

a) **Control.** The first priority is always to fly the aeroplane. Establish control by levelling wings, prevent yaw with rudder and adjust the attitude to achieve and maintain Vyse. (Note that for most light twins Vyse is quoted for maximum all up mass only; at lower mass Vyse is also lower.) Confirm that full power has been selected on all engines and reduce drag by retracting gear and flap.

b) **Identify**. 'Dead leg = dead engine' is the usual method of identifying which engine has failed. However, do not rush into feathering drills just yet – make sure you confirm the diagnosis.

c) **Confirm**. The first action is to close the throttle of the affected engine. If the engine noise changes significantly or the aeroplane yaws towards this engine, then you have got the wrong one! A further clue will be the sudden loss of performance. Put the throttle lever forward and start again.

d) **Feather**. When the failed engine has been confirmed, continue with the feathering drills. Most feathering propellers fitted to MEP aeroplanes are designed in such a way that it is not possible to feather the blades below a certain low rpm (typically 700 to 1000 rpm). It is recommended that pilots refer to AIC 100/05 (Pink 90) for further details. Having successfully reached this stage the aeroplane should be at its best performance with full power and minimum drag. Trim the aeroplane and complete the rest of the engine failure drills when convenient.

e) **Inform ATC**. Make an appropriate emergency call, requesting assistance if required.

f) **Other confusing factors**. Correct identification of the failed engine is vital; you may be confused by other factors such as noise or progressive engine failure.

- Noise. A mechanical failure of an engine is very likely to produce noise and vibration. Do not attempt to identify which engine has failed by your perception of the direction of the noise/vibration.
- Instruments. Instrument indications can be misleading, particularly in normally aspirated engines. For example the manifold air pressure (MAP) on the failed engine could be showing ambient pressure, possibly similar to the live engine MAP indications. If the propeller is windmilling the RPM could be high.
- Progressive engine failure. This is probably the most difficult situation to assess since yaw may be small initially, loss of performance will be progressive and noise and vibration could be high. On the positive side the engine may be producing useful power at first – use it to accelerate and/or climb. Engine failure drills must not be rushed; do not feather the propeller until you have positively identified the failing engine.

5 OTHER EFATO CONSIDERATIONS

a) **Take-off Minima**. In the time between take-off and establishing a safe single-engine climb, the pilot must be satisfied that he can avoid any obstacles visually. This will limit the cloud base and visibility that can be accepted for take-off. For public transport operations cloud base and visibility minima for take-off are specified and mandatory; private pilots would be unwise to use lower minima. Most operators of this class of aeroplane assume that an engine failure at or above 300 feet can be managed into a single-engine climb (gear and flap should already be up by this stage) but below this height an engine failure may result in a forced landing or a very shallow climb. To be able to see ahead therefore, a minimum visibility of 1000 metres would seem reasonable. These figures of 300 feet and 1000 metres are a guide and must be adjusted (probably upwards) for individual circumstances.

b) **Visual Circuit**. If performance and weather permit, a visual circuit would be the quickest way back onto the ground.

c) **Instrument circuit**. In IMC a visual circuit may be out of the question. The type of approach aid available at the aerodrome of departure, the weather conditions, pilot's qualifications and approach minima will determine whether this is a viable option.

d) **Diversion**. If a return to the aerodrome is not viable, the pilot should plan to divert to a suitable destination. In IMC this may well be to an aerodrome that could offer radar and an ILS approach.

6 PRE-TAKE-OFF BRIEF

Now that most of the factors have been considered, a plan of action can be formulated. Before every take-off the pilot should consider the prevailing circumstances and brief himself on his actions in the event of an engine failure during or just after take-off. Where two crew are involved (e.g. an instructional flight) a formal pre-take-off brief should be given by the flying pilot. The brief should include:

- under what circumstances take-off will be rejected;
- whether landing back on is an option;
- preferred area/direction if forced landing required;
- visual/instrument circuit or diversion; and
- pilot/crew actions as required.

7 ASYMMETRIC CIRCUIT/ APPROACH

a) Once safely established in a visual or instrument circuit, aeroplane performance must be considered before reconfiguring for landing. Is sufficient excess performance available to cope with the extra drag of gear and flap? At high mass and/or ambient temperature some MEP aeroplanes may not be able to maintain level flight with the gear down. Sound system knowledge is also required; can the gear/flap be extended/retracted using the normal system?

b) Power changes can be kept to a minimum by using gear and flap selection to assist in the control of speed and flight path. For example, partial flap may be selected on the down-wind leg to reduce speed towards approach speed. Gear selection should coincide with commencing descent onto final and further stages of flap may be considered to adjust speed. Keep power changes to a minimum to avoid large trim changes. A shallow approach will require more power, so maintain at least a nominal (3°) approach path.

c) Keep the speed close to Vyse as you approach committal height.

8 ASYMMETRIC COMMITTAL HEIGHT

a) Many people misunderstand the concept of asymmetric committal height (ACH). Ideally a pilot making an asymmetric approach will land from the first approach. However, there are circumstances when this is not possible and a go-around becomes necessary. Due to the low performance and relatively high drag, the transition from approach configuration to single-engine best rate of climb will entail certain height loss. In essence ACH allows for this height loss; it is the minimum height from which an asymmetric approach may be abandoned to achieve a safe climb at Vyse.

b) On an asymmetric approach, once below ACH, a pilot is effectively committed to land. Note, however, that in certain circumstances a pilot may be committed to land from above ACH. For example if the gear cannot be raised or if the airframe has accumulated ice, the aeroplane may not have the performance to go-around. Similarly, a pilot may elect to commit himself to land from above ACH. For example from a stable approach, with a clear runway and with landing clearance, full flap may be selected above ACH. The point is that he should not put himself into a position from which he has no choice but to land until he has a high degree of confidence that a landing will be successful. A useful guide in making this decision is to satisfy the following criteria.

- Correct speed and stable approach.
- Configured for landing (gear down at least).
- Clear runway.
- Clearance to land.

9 CONCLUSION

a) In some ways training for MEP aeroplanes does not give the full picture. All of the various responses to engine failure cannot be practised safely during training in the air; some must be left for discussion on the ground (or training in a synthetic trainer such as an FNPT). Asymmetric training is often carried out on relatively lightly loaded aeroplanes and pilots are anticipating simulated engine failures, therefore they may have a high expectation of the aeroplane's performance and their own ability. In reality single-engine performance on MEP aeroplanes may be very limited; a forced landing is a possibility that should be considered. Pilots must be prepared to react quickly and accurately to engine failure; in particular the accurate identification of the failed engine is crucial. Additionally, pilots must understand the systems on their aeroplane and be totally familiar with the handling notes in the Owner's Manual or Pilot's Operating Handbook.

b) Finally, the options a pilot chooses should be pre-planned and reinforced by (self) briefing of the stages of take-off, identified at paragraphs 3a, b, c and d, prior to every take-off.