WINDMILLING WARNING

Owners and operators of piston multi-engine aeroplanes need to understand the dangers of a windmilling propeller preventing level flight with one engine inoperative.

A Swiss-registered Cessna 421 flying in France experienced an engine failure due to a failed crankshaft. The pilot initially continued towards his intended destination, but after several failed restart attempts, he decided to divert to another airport. The pilot announced that he was unable to restart the engine and was unable to feather the propeller. The aeroplane continued to descend until it impacted the ground.

There are two possible reasons the pilot could not feather the propeller. Either the motion of the failed crankshaft quickly slowed the propeller below the start-lock disengagement speed, or because – having unfeathered the propeller for the start attempts – the pilot was unable to re-feather the propeller because the motion of the failed crankshaft would not allow the propeller to rotate above the start-lock disengagement speed.

A piston multi-engine aeroplane with an engine failure will experience increased drag and lower performance under the following conditions:

- The pilot is unable to feather the propeller on the inoperative engine.
- The pilot then attempts a restart of the failed engine and un-feathers the propeller using the un-feathering accumulators or starter.
- The engine fails to restart.
- The propeller will not go back into feather as the propeller windmilling speed is below the start-lock disengagement speed.

Aircraft performance is determined by the amount of available power and total aircraft drag. The amount of available power in excess of the aircraft total drag dictates the aircraft's ability to climb. The loss of an engine in a piston multi-engine aeroplane dramatically reduces the amount of available power. (The relationship of drag versus available power is shown in figures 1 and 2).

The one engine inoperative (OEI) climb performance charts are in the performance section of the pilot's operating handbook

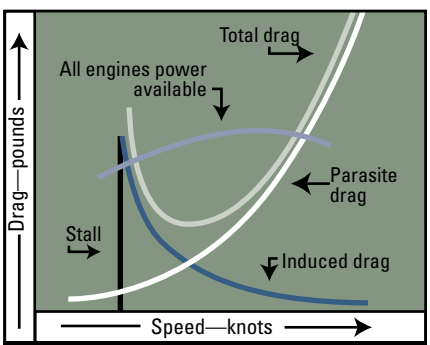

Figure 1: All engines operating

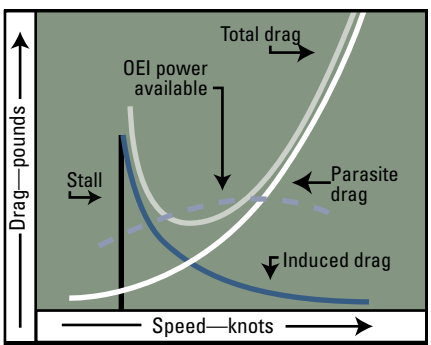

Figure 2: One Engine inoperative

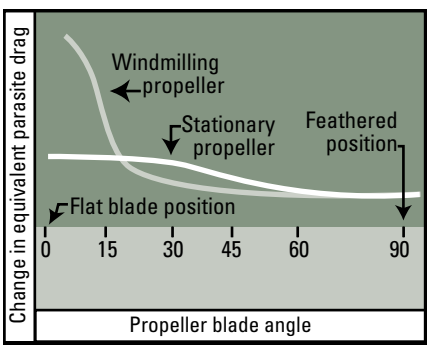

Figure 3: Windmilling propeller parasitic drag

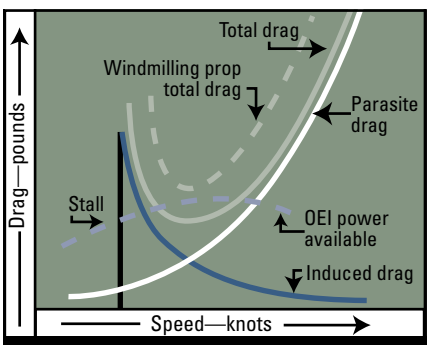

Figure 4: Windmilling propeller total drag

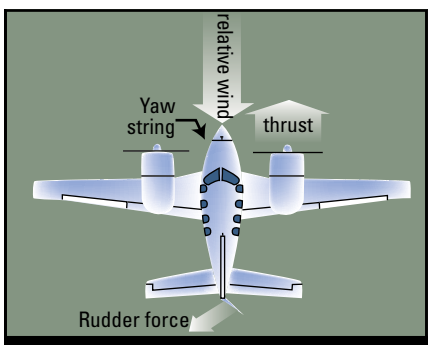

Figure 5: OEI with a windmilling propeller asymmetric drag

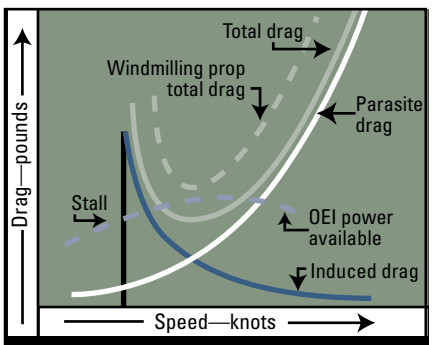

Figure 6: OEI with a windmilling propeller drag and power effects

Rob Fox. Photo for illustrative purposes only

Takeoff trouble: Loss of control following engine failure on takeoff has claimed the lives of many experienced Australian aviators

(POH). OEI climb performance is affected by weight, altitude, temperature and aircraft configuration. The usual aircraft configuration for maximum OEI climb performance is:

- Operating engine is at full power.
- Landing gear is up .
- Flaps are up.
- Propeller is feathered on the inoperative engine.
- Wings are banked 5° towards operative engine.

There are areas of the aircraft performance envelope where the aeroplane's climb performance is negative. A survey of pilot operating handbooks for several piston multi-engine aeroplanes revealed that the following – or similar – warning is contained in the emergency procedures section: "WARNING: Level flight may not be possible for certain combinations of weight, temperature and altitude".

The inability to maintain level flight is exacerbated by a windmilling propeller. A windmilling propeller is a large producer of parasitic drag. The effects of a windmilling propeller on parasitic drag and total aircraft drag are shown in figures 3 and 4.

In the case of a piston multi-engine aeroplane, the effect of a windmilling propeller is to increase the total drag of the aeroplane and induce an asymmetric drag about the yaw axis. The summation of the effects of one engine inoperative with a windmilling propeller are shown in figures 5 and 6.

The net result of a windmilling propeller is the aircraft total drag exceeds the power available – as a result, the aircraft is no longer able to sustain level flight.

The inability to feather a propeller on the inoperative engine can be a result of improper maintenance, failure of the propeller control, internal failure of the propeller components, or the propeller windmilling speed being below the start-lock disengagement speed.

A survey of various POHs showed consistent advice to land as soon as practicable following an engine failure. However, there was a lack of definitive guidance about when the pilot should conduct a re-start. One POH in the survey addressed the issue with the following statement: "CAUTION: The pilot should determine the reason for engine failure before attempting an air start".

The FAA recommends that you do the following about one engine inoperative (OEI) operation:

- Land as soon as practicable following an engine failure.
- Once an engine is shut down and its propeller feathered, avoid un-feathering the propeller unless you know why the engine failed, you are certain that the problem is resolved, and you are reasonably confident that the engine can be restarted.

Adapted from FAA Special Airworthiness Information Bulletin, CE-05-51, published April 2005.