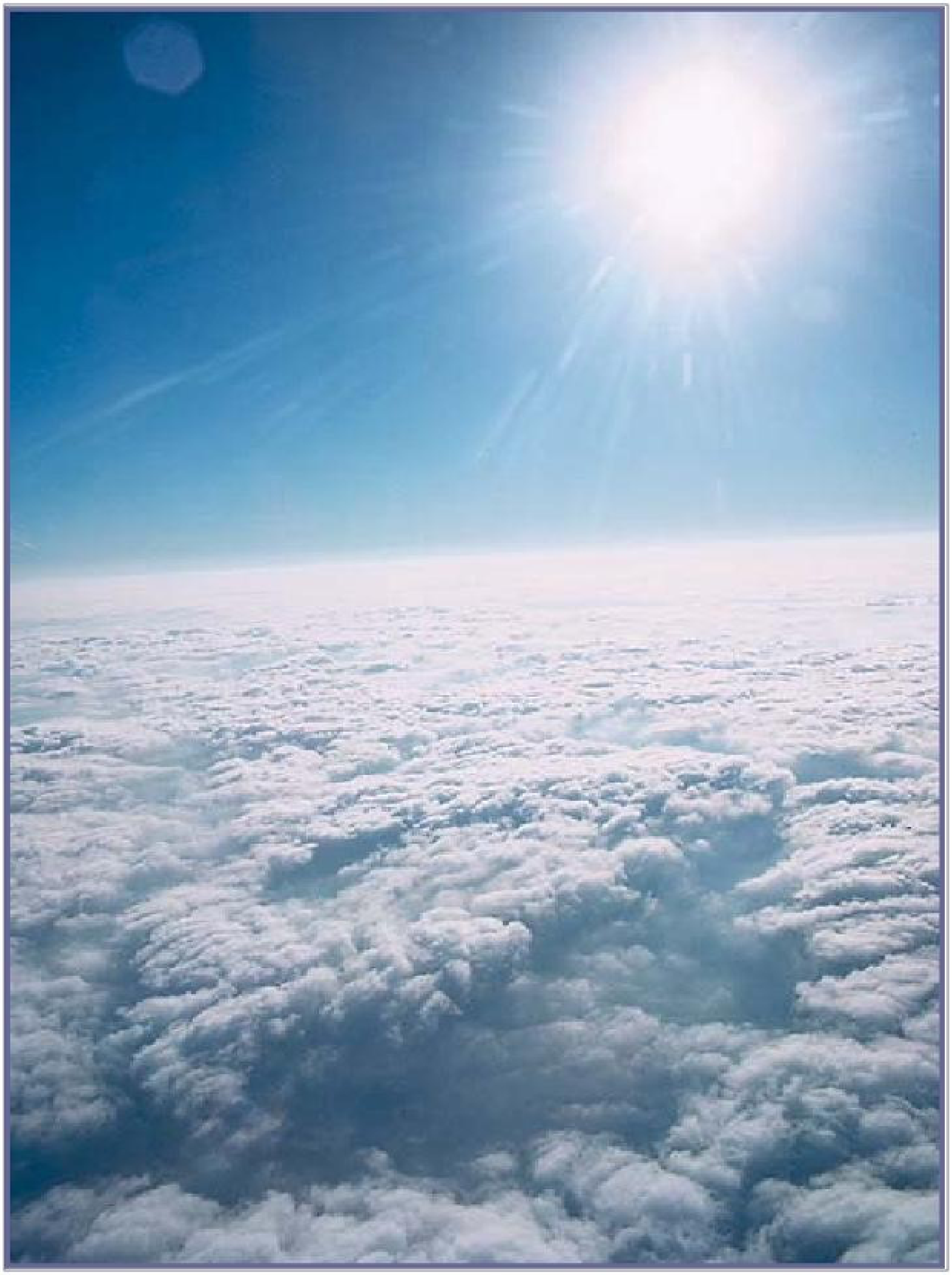

Multiengine Manual and MEI Notebook

Reference notes for the private, commercial, and airline transport multi-engine pilot and instructor

BETH ANN JENKINS ATP CFI CFII MEI CFI-G
STEPHANIE FERNIHOUGH CFI CFII MEI
JOSÉ HIRAM SOLTREN CFI CFII

Pilot's Choice Aviation, Inc.
Soltren Consulting LLC

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For Zoë, Sebastian, and Malcolm, who hopefully find as much inspiration from me as I do from them.
I hope they learn to fly one day too.
–José Soltren

Contents

Multi Engine Airplanes:
An Introduction

Do you want to fly the “big iron”? Are you looking for more performance, capability, and reliability? Do you enjoy engine management (and maintenance) so much that you want to double the fun? If so, the multi engine airplane is for you.

This chapter is meant to prepare the prospective multi engine pilot or instructor for the fun that is to come.

The material in this section is based upon FAA resources, as well as the Multiengine Manual that Pilot’s Choice Aviation (PCA) in Georgetown, TX distributes to incoming multi engine students. This document could not exist without Beth Ann Jenkins and Stephanie Fernihough, the authors of the 2017 PCA Multiengine Manual and some notes beyond it.

The Multiengine Manual was reformatted into LaTeX in Spring of 2025. At that time, it was updated to reflect eight years of students successfully using this document to become multi engine pilots. It also reflects the latest FAA testing documents as of this writing.

This Manual focused on the Beechcraft Duchess BE76, the primary multi engine trainer used at PCA.

Disclaimer

The information contained in this publication is subject to change.

Aeronautical information, regulations, and aircraft information change regularly, therefore those relevant publications should be referred to for any critical information.

The information in this manual is to be utilized for training purposes only. Always refer to your aircraft's POH, AFM, and other certified documentation before flight!

Chapter 1

Single Engine Aerodymanics

With a few exceptions, flying a multiengine airplane in normal operations is similar to flying a complex single. Most of the differences between single-engine and multi-engine flying relate to emergency situations. Specifically, we are concerned with the airplane's flight characteristics when only one engine is fully operating.

The discussion to follow will focus on two key elements of multi-engine flying: performance and controllability.

Note: *performance* and *controllability* are complementary. As one increases, the other decreases, and vice versa.

1.1 The Engine-Inoperative Condition

1.1.1 Asymmetric Thrust

Engines on conventional twins are mounted on the wings. Unlike a single-engine airplane, the engine thrust is not directed along the longitudinal axis of the airplane. Rather, each engine's thrust produces a moment that attempts to yaw the airplane around its vertical axis. On the Duchess (one counter-rotating prop) when both engines are producing equal thrust, these moments balance each other out and the net thrust has no yawing moment. When one engine is at reduced or zero thrust, there is a net yawing moment that will lead to a loss of directional control if not counteracted.

Just like in a single, yawing moments (such as propeller left-turning tendencies in a climb) are counteracted with rudder. When an engine fails in a multi-engine airplane, the yaw that occurs must be balanced out with enough rudder pressure to keep the airplane straight. Rudder effectiveness is a function of airspeed – more air flowing over the rudder airfoil gives it the ability to produce more horizontal lift.

1.1.2 Accelerated Slipstream

Because the engines on a conventional twin are wing-mounted, additional lift is produced by the accelerated slipstream of the propeller wash over the wing surface. The loss of thrust on one wing results in a loss of lift on that wing which produces an imbalance of lift between the two wings, leading to a rolling moment toward the inoperative engine. This rolling tendency must be counteracted with aileron deflection.

1.1.3 Summary

Because of the above listed factors (asymmetric thrust and accelerated slipstream), both produced by the operating engine, there is a tendency for the airplane to *both* roll *and* yaw into the inoperative engine!

1.2 Engine-Inoperative Performance

1.2.1 Loss of Horsepower

A common misconception is that with one engine out, a twin will have half the climb performance that it would with both engines. In reality, for aircraft with a maximum gross weight of less than 6,000 pounds, there is no requirement that they be capable of level flight or climb for *any* weight or flight condition! The only requirement is that the rate of climb or descent be determined. Many light twins are not capable of holding altitude with one engine.

The Duchess has two 180-HP engines for a total of 360 HP, and requires about 140 HP to maintain level flight. Losing one engine drastically cuts the horsepower available for climb performance:

360	**total HP available**
(140)	**HP for level flight**
220	**HP left for climb performance**
(180)	**HP – loss of an engine**
40	**HP now available for climb**

Table 1.1: Single engine performance for the Duchess.

This means we now have only approximately 20% (40/220) climb performance remaining. In addition, it should be stressed that the airplane must be cleaned up to climb. Anything that creates drag will require additional horsepower and will decrease the airplane's climb performance.

Further, realize that 180 HP is the rated horsepower for sea-level standard conditions. Depending on density altitude (pressure altitude and temperature) effective horsepower may be less than 180 HP. This means that you *may not be able to maintain altitude with only one engine*. Maintaining V_{yse} (blue line) will give you a best rate of climb or the least rate of descent.

1.2.2 V_{yse} (Blue Line)

V_{yse} is the maximum rate of climb (or minimum rate of sink) airspeed for a single-engine configuration. It represents the maximum lift over drag ratio (L/D_{max}) with one engine operating, and may be likened to the best glide speed in a single-engine airplane. At slower airspeeds, induced drag becomes more prominent. At faster speeds, parasite drag becomes more prominent.

V_{yse} is the minimum speed to use during all phases of flight and is to be exceeded until committed to land on short final. V_{yse} is the minimum speed above which you can commit to a continued takeoff. V_{yse} is the minimum speed to use during emergencies involving an engine failure. V_{yse} is marked by a Blue Line on the airspeed indicator (85 KIAS on the Duchess).

1.2.3 Drag Factors

With one engine inoperative, several factors will determine whether or not you'll be able to maintain altitude, climb or descend. These drag factors increase the horsepower required for level flight, and eat into the excess horsepower which could be used for climb. All figures are approximate and will vary with density altitude:

1. Not at V_{yse} – High or low by 5 knots: **100 fpm descent**
2. Gear Down: **250 fpm descent**
3. Full Flaps: **350 fpm descent** (flaps @ 20 = 150 fpm descent)
4. Critical engine windmilling: **300 fpm descent**

Single engine goarounds may be impossible and **shall not be attempted with flap settings beyond 20 degrees**.

Each twin has a single engine service ceiling and an absolute single engine ceiling:

- The **single-engine service ceiling** (Duchess: 6000 ft @ ISA) is the maximum *density altitude* the airplane can sustain a 50 fpm climb with max power on the good engine in the clean configuration.
- The **single-engine absolute ceiling** (Duchess: approximately 7800 ft @ ISA) is the maximum *density altitude* the airplane can maintain on one engine with max power in the clean configuration. This is also the altitude where V_{yse} and V_{xse} meet.

1.2.4 Engine-Inoperative Controllability

In a single-engine airplane, keeping the aircraft under control (avoiding a stall) is critical. Even if performance is below that required to maintain level flight, we accept a descent and a controlled landing rather than try to hold off the descent and get into a stall/spin situation. While stalls are a concern in multi-engine aircraft, another important consideration is the possible loss of directional control if airspeed is not managed correctly.

With all this in mind, it can be said that the battle for controllability is one between engine and rudder. Anything that increases the difference in thrust between the two engines will decrease controllability, and anything that makes the rudder more able to counteract the thrust difference will increase controllability.

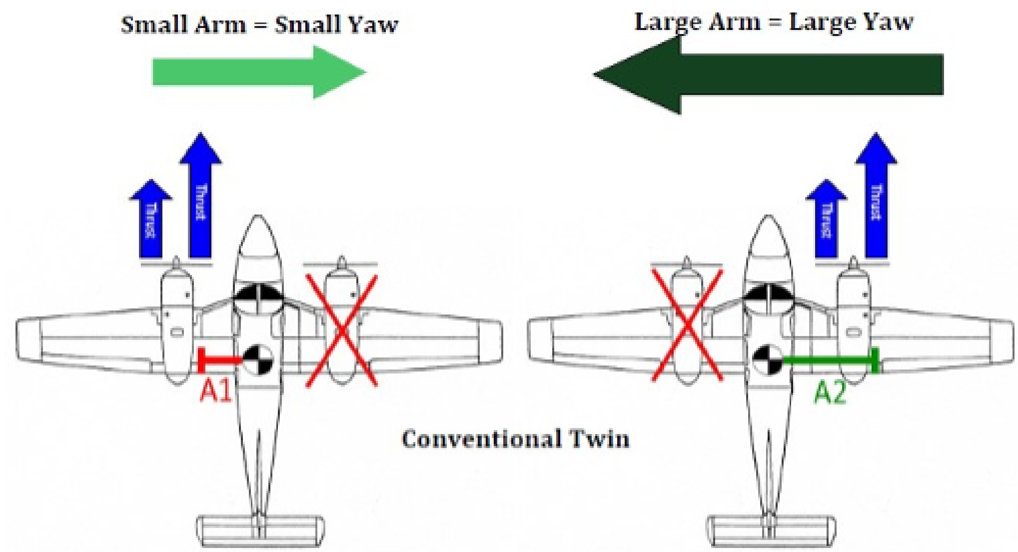
1.2.5 Critical Engine and Critical Engine Factors

The critical engine is the engine whose failure most adversely affects the performance and controllability of the airplane. In general, one of the engines will have a larger yaw moment and the airspeed needs to be higher in order to balance it out. When the airplane has counter-rotating props (such as the Duchess) there is no critical engine. On most twins, both propellers rotate clockwise when viewed from the cockpit. On these aircraft, the left engine is critical. The reasons for this are explained below.

The following discussion assumes a conventional light twin, with two clockwise-rotating propellers. On such airplanes, the critical engine is the left engine, because the left-turning tendencies of the right engine add to its asymmetric thrust. The left turning tendencies are discussed below. (PAST)

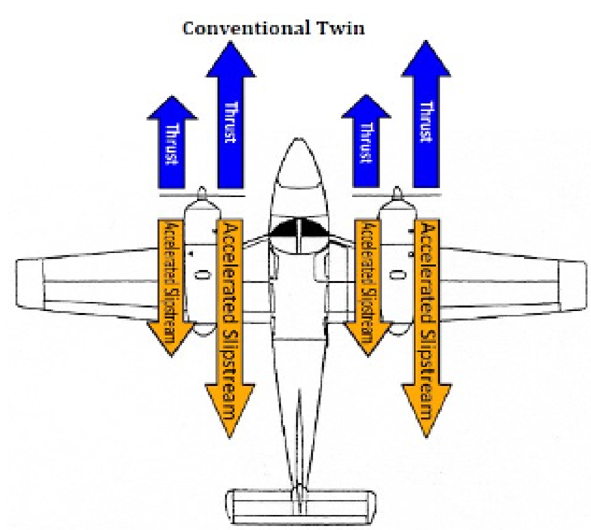
P factor

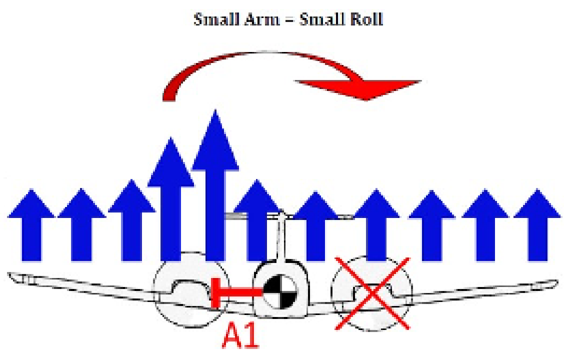
The descending blade produces more thrust than the ascending blade. The descending blade on the right engine has a longer moment arm (A2) than on the left engine (A1). This produces greater asymmetric thrust when the right engine is operating than when the left engine is operating.

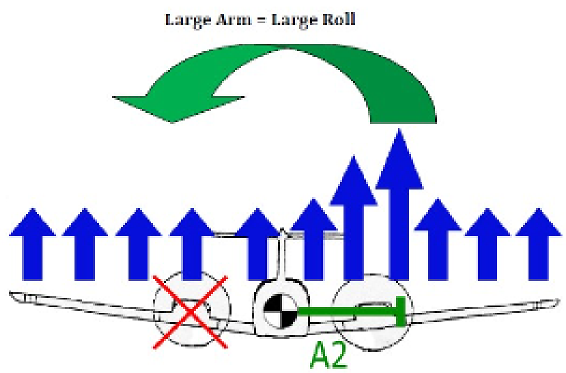


Accelerated Slipstream

The loss of induced airflow created by the propeller over the dead engine wing results in a loss of lift on that wing. This loss of lift causes a roll towards the dead engine and will require additional aileron deflection into the operating engine. Due to P-factor, the accelerated slipstream of the right engine has a longer moment-arm (A2) than the left engine (A1) because the descending (greater-thrust) propeller blade is outboard.

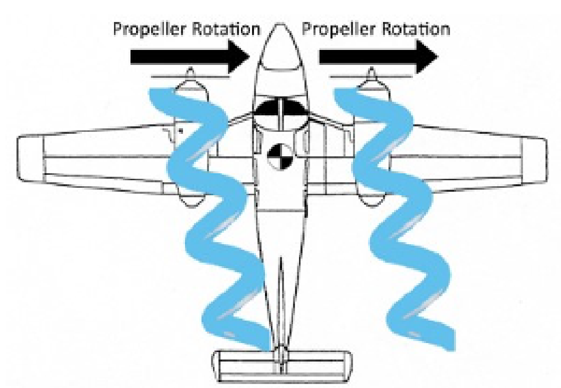






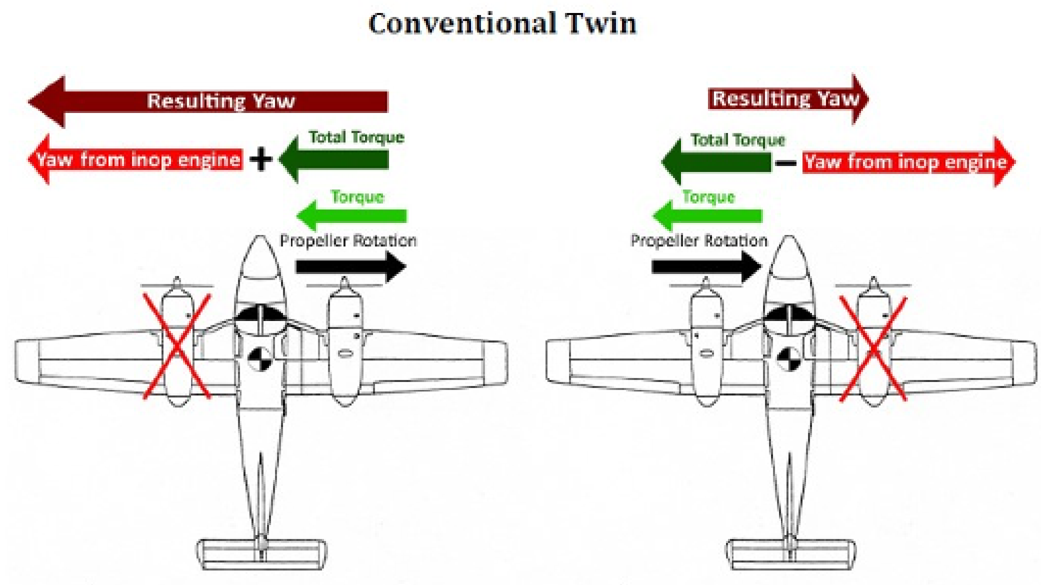
Spiraling Slipstream

Both engines produce spiraling slipstreams, but the left engine's spiraling slipstream is directed towards the rudder, making it more effective. The right engine's spiraling slipstream is directed away from the rudder. In the event of left engine failure, the rudder becomes less effective due to the loss of the critical engine's spiraling slipstream. Therefore, with critical engine failure maintaining directional control requires more rudder authority.



Torque

Torque is the opposite reaction to the clockwise turning of the propellers. Both engines produce a rolling tendency to the left. With the right engine operating (critical engine inoperative), torque adds to the yaw/roll produced by asymmetric thrust. With the left engine operating, torque counteracts the yaw/roll produced by asymmetric thrust.



1.2.6 V_{MC}

V_{mc} is defined as the minimum speed at which you can maintain directional control with ithe sudden loss of the critical engine. The actual speed at which you will lose directional control will vary depending on conditions on a given day. The *published* V_{mc} *airspeed* is dictated by a set of conditions in 14 CFR (FAR) 23.149. V_{mc} is marked with a **red line** on the airspeed indicator. For the Duchess, this airspeed is 65 KIAS.

On August 30, 2017, a substantial rewrite of 14 CFR (FAR) 23 went into effect. This rewrite eliminated 23.149 from the current regulations. However, it remains the certification basis for many of the light piston twin airplanes we fly today. For light twins certificated under the new Part 23, such as the Tecnam P2006, we would see similar requirements under 14 CFR (FAR) 23.2xxx. Since this document focuses on the Duchess, we restrict our discussion to the “old” 14 CFR (FAR) 23, which is archived on ecfr.gov.

1.2.7 Determination of V_{MC}

Under the “old” 14 CFR Part 23, manufactures of multiengine aircraft were required to demonstrate and publish a V_{mc} (minimum control airspeed) under the following specific conditions, which are either set for Standardization (S), or are the Worst Case (W):

1. **Standard Day** (S) (15°C and 29.92" at sea level)
2. **Maximum sea level takeoff weight** (S)
3. **The most rearward allowable center of gravity** (W)
4. **The critical engine failed** (W) and the propeller is
   (a) Windmilling, or
   (b) Feathered, if the aircraft has an auto feather system (rare in light twins)
5. **Takeoff at maximum available power on the good engine** (W)
6. **Landing gear up** (W)
7. **Flaps in the takeoff position** (S)
8. **No more than 5° of bank into the good engine** (S)

A further factor is the pilot ability, Part 23 states that recovery from loss of directional control at V_{mc} should not require more than average pilot technique and the recovery should be accomplished within 20° of original heading.

Apart from the 5° bank, max gross weight, standard day, and flaps, the remaining factors are all worst case, and they lead to the highest V_{mc} to be published by the manufacturer (65 KIAS for the Duchess), or are related to the takeoff scenario.

When considering V_{mc} , realize that lower V_{mc} is better. Anything that lowers V_{mc} will increase controllability at lower airspeed, giving more margin for error in single-engine operation.

Conditions that the FAA Requires for Published V_{mc} (14 CFR 23.149)

What follows is a list of conditions required to be met by manufacturers in determining the published V_{mc} value for certification. Understanding the regulatory criteria is important for understanding how existing conditions and aircraft control influence single-engine controllability.

The conditions required for certification represent the worst-case scenario for controllability: an engine failure shortly after takeoff, with the aircraft in the climb-out configuration. However, not every condition required for certification is necessarily worst-case (W); some conditions are specified primarily for standardization purposes (S).

Standard conditions (ISA: 15°C and 29.92" Hg) (Standardization)

V_{mc} decreases with increase density altitude. Any condition that decreases power on the operating engine such as increased altitude, low air density or high temperature will in turn mean less thrust, which creates less yaw, so V_{mc} will decrease. The opposite is also true for any condition that increases power, such as lower altitude, high density or low temperature, which will increase V_{mc} .

Memory aid: Hot = Good

Maximum sea-level power on operating engine (Worst case)

Maximum power on the good engine increases V_{mc} due to increased asymmetric thrust.

Critical engine windmilling or auto-feathered if installed (Worst case)

The windmilling propeller creates drag, which is asymmetric. Therefore, more rudder authority will be required to offset this asymmetric drag. V_{mc} is higher with a windmilling propeller on the inoperative engine.

Landing gear retracted (Worst case)

The gear and gear doors extended tend to act like keels on a boat and resist rolling and yawing tendencies by shifting the center of gravity down the vertical axis of the airplane. Additionally, on a tricycle-gear airplane, the main gear are located aft of the center of gravity and produce *stabilizing drag* when extended, like a drag chute would. V_{mc} is *lower with gear down.*

Flaps in the takeoff configuration (Standardization)

A number of considerations determine the relationship between flap setting and V_{mc} . With flaps extended a lesser angle of attack is necessary to produce the same amount of lift. Therefore, P-factor is less as well as yaw. Additionally, flaps increase drag aft of the C.G., providing a stabilizing effect. However, deploying flaps creates additional lift on the wing with the operating engine since lift increases with the same airspeed. Therefore it is not straightforward to say that V_{mc} changes one way or the other with flaps deployed, and this relationship may vary depending on the airplane.

The Duchess procedures call for flaps fully retracted for takeoff.

Maximum 5° bank into good engine (Standardization)

The maximum bank allowed by the regulations for V_{mc} determination is five degrees. Any sideslip toward the good engine increases controllability due to increased rudder effectiveness – the sideslip results in weathervaning tendencies toward the operating engine. Likewise, sideslip toward the inoperative engine decreases controllability by introducing a weathervaning moment away from the operating engine. Specifying a maximum of five degrees limits the manufacturers to a realistic bank angle.

It should be remembered that a bank angle of three degrees towards the good engine with the ball 1/2 off-center results in minimum drag and maximum climb. Five degrees of bank towards the good engine actually results in a sideslip toward the good engine, increasing drag but increasing controllability.

Maximum gross weight (Standardization)

V_{mc} is determined at max gross weight. Primarily this is a reference point for standardization purposes.

When the airplane is banked, a sideslip occurs because a component of weight is acting along the wing (similar to the idea of a wing-down crosswind approach). The spanwise component of weight and sideslip is greater at a higher weight than a lower weight. Because of this, when the airplane is banked into the operative engine beyond the zero-sideslip angle, V_{mc} increases with the decrease in weight, and vice versa.

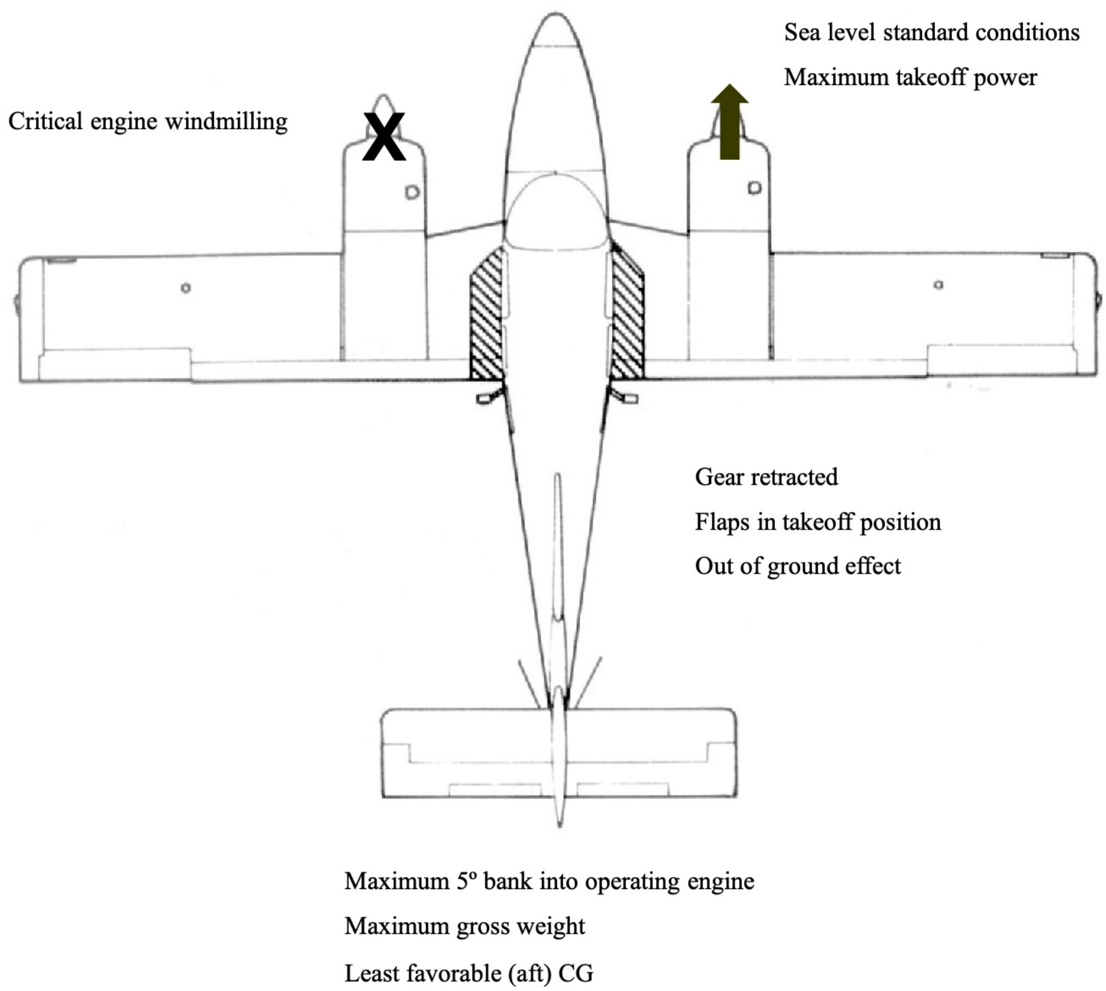
Memory aid: Weight increases side slip effectiveness and lowers V_{mc} *.*

Most adverse CG (usually aft legal CG limit) (Worst case)

As the CG moves aft, the moment arm between the rudder and C.G. is shortened, producing less leverage for the rudder. The further aft the C.G., the more rudder authority is required to offset the asymmetric thrust, requiring greater airspeed. V_{mc} is higher with an aft C.G.

Ground effect negligible (Worst case)

In ground effect there is a reduction in induced drag, so if an engine failure should occur while in ground effect a lower than normal angle of attack would be required to create the same amount of lift as when out of ground effect. A lower angle of attack would decrease the effect of P-factor, reduce yaw, and lower V_{mc} . Operating out of ground effect results in a higher V_{mc} than in ground effect.



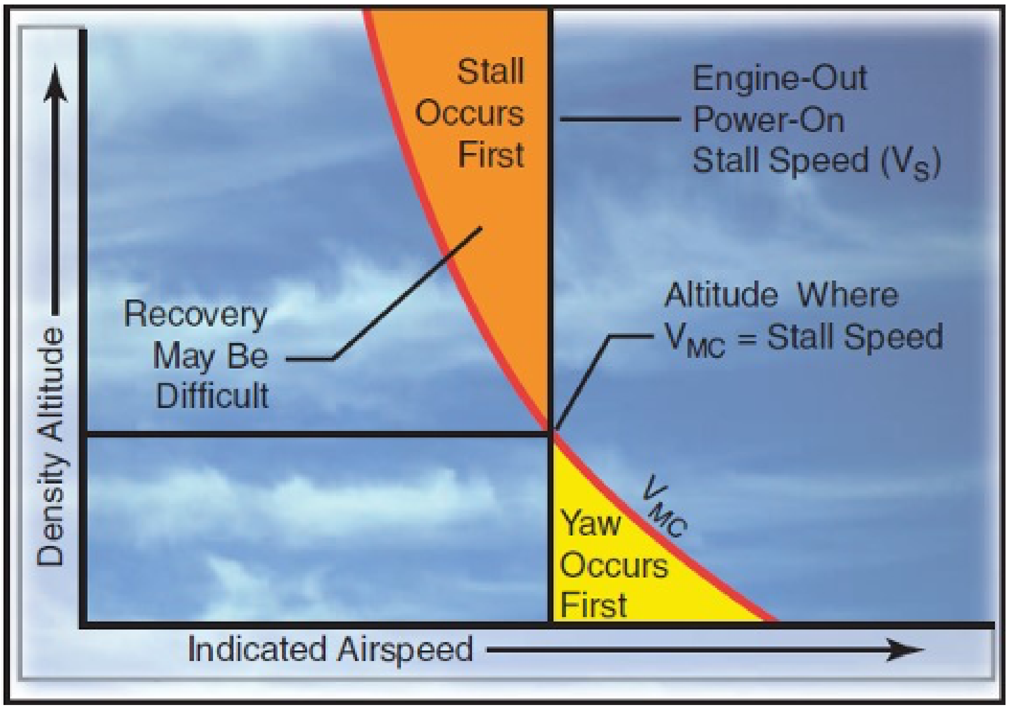
*Memory aid: Any increase in yaw or decrease in rudder authority **increases** V_{mc} !*

Memory aid: In the least favorable (aft) CG, the arm to the rudder is reduced, so the rudder is less effective.

1.3 Altitude vs. V_{MC} and Stall Speed

As density altitude increases, V_{mc} will decrease due to less power output from the operating engine (you'll lose directional control at a slower airspeed). Indicated stall speed remains relatively constant for all density altitudes. Thus, it is easily possible for V_{mc} to be lower than stall speed. When this happens a possible spin could develop during V_{mc} demonstrations or during other single-engine operation, real or simulated.

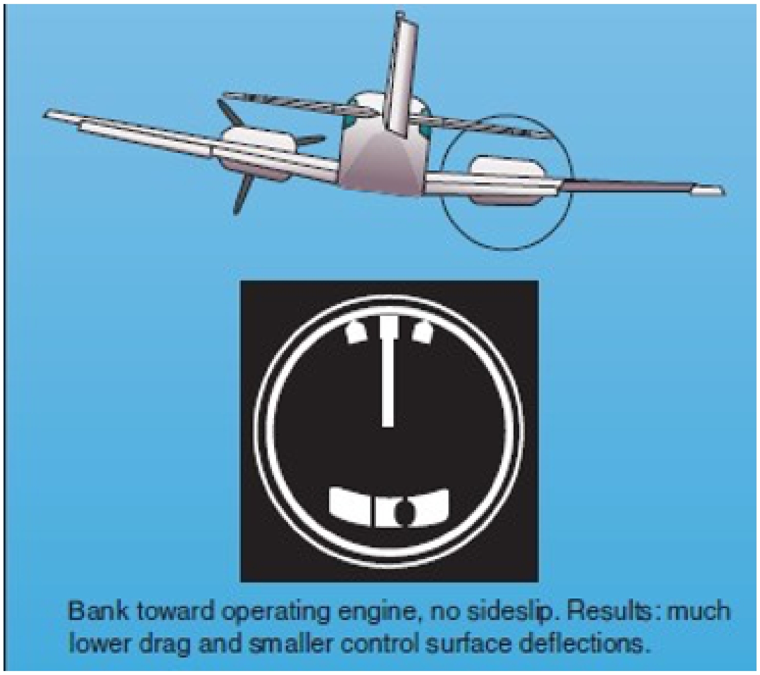
If loss of directional control occurs during single-engine operation, **IMMEDIATELY** reduce power on the good engine and lower the nose to regain airspeed.



1.4 The Zero-Sideslip Condition

As previously stated, a twin with only one engine operating must counteract the yaw and roll produced by asymmetric thrust with rudder and aileron. The asymmetric thrust and the **horizontal lift** produced by the rudder result in a net sideslip toward the **inoperative** engine when the wings of the airplane are held level, causing a turn *away* from the operating engine. This sideslip increases drag and degrades performance just as a sideslip would in a single.

To overcome this sideslip, the airplane must be banked into the operative engine. The sideslip caused by the bank angle and ball half-centered cancels out the sideslip created by the engine and rudder resulting in a **zero-sideslip condition**. The zero-sideslip condition reduces drag and therefore improves climb performance (or minimizes rate of descent). In the Duchess, the bank angle that results in zero sideslip is approximately three degrees.



Memory aid: Heavier means good engine is less effective, which reduces V_{mc} .

Memory aid: Tail induces centripetal force which turns the airplane. So, you have to counteract that turn with a bank angle of $3°$.

Chapter 2

Limitations

2.1 Duchess Speeds

V_{MC}	**65**	Minimum control speed.
V_{S0}	**60**	Stall: landing configuration.
V_{S1}	**70**	Stall: clean configuration.
V_{XSE}	**85**	Best rate of climb, one engine.
V_{YSE}	**85**	Best angle of climb, one engine.
V_{SSE}	**71**	Intentional one engine inoperative speed.
V_A	**132**	Maneuvering speed (at Max gross weight).
V_{LO}	**140/112**	Landing gear operating extend/retract.
V_{LE}	**140**	Max landing gear extended.
V_{FE}	**120/110**	Max flaps extended 20/35.
V_{NO}	**154**	Max structural cruising speed.
V_{NE}	**194**	Never exceed speed.
V_R	**71**	Rotation speed. For training purposes, V_R is increased to 80.
V_X	**71**	Best angle of climb.
V_Y	**85**	Best rate of climb.
	140	Emergency descent. *Do not exceed!*
	100	Emergency landing gear extension (free fall), maximum.
	95	Best glide: 12:1 with propellers feathered.
	25	Maximum demonstrated crosswind component.

2.2 Weight Limits

Maximum Ramp Weight	3916 Pounds
Maximum Takeoff Weight	3900 Pounds
Maximum Landing Weight	3900 Pounds
Maximum Zero Fuel Weight	3500 Pounds
Maximum Baggage Compartment Load	200 Pounds

Chapter 3

Emergency Procedures

KNOW PROCEDURES BY MEMORY!

3.1 Engine Failure in Flight (above 3000' AGL)

3.1.1 Procedures

Maintain directional control!

ALL AVAILABLE POWER:

1. **PITCH FOR BLUE LINE -** V_{yse} **(85 KIAS),**
   OR maintain altitude at a higher airspeed if able.
2. **MIXTURES SET (max available power)**
3. **PROPELLERS Full Forward**
4. **THROTTLES Full Power**

CLEAN UP:

1. **FLAPS UP (or as required)**
2. **GEAR UP (or as required)**
3. **Trim and bank into good engine.**

IDENTIFY/VERIFY:

1. **IDENTIFY Dead foot = dead engine.**
2. **VERIFY Power idle on dead engine. No change in performance - verified.**

FIX OR FEATHER:

- **DECISION Based upon situation/altitude (Restart or Feather?)**

Rarely do engines fail suddenly and completely (fuel starvation is the exception). If an engine is running poorly, but developing some power, **you are better off letting it run** (above 3000 AGL) until you sort out the problem. The decision to feather should be made with some deliberation. A catastrophic engine failure would require feathering the engine (avoiding a potential fire), however, a rough running engine should not be feathered as any horsepower it is producing potentially helps.

The exception is during a critical phase of flight, such as initial climb-out, approach or landing. During these phases of flight the propeller on the problem engine should be feathered immediately, as there is not enough time to safely perform the fix procedures. Maintaining aircraft control is *the priority* and you should land as soon and as safely as possible.

FIX:

CHECK (Red Items) - only on affected engine.

1. **Fuel - ON**
2. **Carburetor Heat - ON**
3. **Mixture - SET (max available power)**
4. **Boost Pumps - ON**
5. **Magnetos - CYCLE Left - Right - Both**

WARNING **Feathering the wrong engine is incredibly dangerous! Work methodically to make certain the correct engine is feathered.**

FEATHER:

1. **Feather Propeller on inoperative engine.**
2. **Power as needed on good engine to maintain altitude/airspeed.**
   Minimum speed: BLUE LINE 85 KIAS.

Memory aid: 3° bank for slip.

SHUTDOWN AND SECURE ENGINE:

- **Mixture - Idle Cutoff**
- **Fuel Selector - OFF**
- **Cowl Flaps - Open on operative engine, closed on inoperative engine.**
- **Fuel Pump - OFF**
- **Magnetos - OFF**
- **Alternator Switch - OFF**
- **Notify ATC.**
- **Land as soon as practical.**

**** NOW REFER TO CHECKLIST. ****

3.2 Engine Failure During or After Takeoff

3.2.1 Procedures

DURING INITIAL CLIMB OUT THE NOSE NEEDS TO BE LOWERED 5 DEGREES OR MORE TO MAINTAIN 85 KIAS!!!

Bank approximately **3 degrees** toward the good engine with the rudder ball half out toward the good engine. This will provide maximum climb performance. **Each degree of bank back toward the inoperative engine increases V_{mc} by 3 knots per degree. Therefore, with only a 2 degree bank toward the operative engine, V_{mc} might be 3 knots higher than published.**

If the pilot inadvertently or instinctively tries to hold wings level in an engine out situation, V_{mc} **CAN INCREASE AS MUCH AS 15 KNOTS. THE AIRCRAFT COULD BE UNCONTROLLABLE AT A SPEED AS HIGH AS V_{yse} !** This situation **WILL EXIST** if the pilot flies wings level and tries to maintain heading with the ball centered.

Memory aid: Raise the dead (engine).

3.2.2 Power-Loss Briefing (Before Takeoff)

A power loss briefing is to be given before takeoff to remind the pilot of the actions to be taken in the event of a power loss during or after the takeoff roll. Time is critical so actions must be immediate but deliberate.

Loss of directional control on the ground:

- **Throttles - IDLE**
- **Regain Control (mostly rudder)**
- **Brake straight ahead**

Airborne loss of directional control: usable runway remaining and gear down:

- **Throttles – IDLE**
- **Land**
- **Brake straight ahead**

Airborne loss of directional control: no usable runway remaining or gear up:

- **All available power (maintain Heading and Blue Line):**
- **Clean Up**
  - ➢ **Flaps – UP**
  - ➢ **Gear – UP**
- **Identify dead engine**
- **Verify dead engine**
- **Feather dead engine**
- **Return for landing**

3.3 Airman Certification Standards

Source: FAA-S-ACS-7B, Commercial Pilot for Airplane Category Airman Certification Standards, November 2023

3.3.1 X.A Maneuvering with One Engine Inoperative (AMEL, AMES)

References:	*FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; FAA-P-8740-66; POH/AFM*
Objective:	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with maneuvering with one engine inoperative.
Note:	*See Appendix 2: Safety of Flight and Appendix 3: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.*
Knowledge:	The applicant demonstrates understanding of:
CA.X.A.K1	Factors affecting minimum controllable speed (VMC)
CA.X.A.K2	VMC (red line) and best single-engine rate of climb airspeed (VYSE) (blue line).
CA.X.A.K3	How to identify, verify, feather, and secure an inoperative engine.
CA.X.A.K4	Importance of drag reduction, including propeller feathering, gear and flap retraction, the manufacturer's recommended control input and its relation to zero sideslip.
CA.X.A.K5	Feathering, securing, unfeathering, and restarting.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.X.A.R1	Potential engine failure during flight.
CA.X.A.R2	Collision hazards.
CA.X.A.R3	Configuring the airplane.
CA.X.A.R4	Low altitude maneuvering, including stall, spin, or controlled flight into terrain (CFIT).
CA.X.A.R5	Distractions, task prioritization, loss of situational awareness, or disorientation.
Skills:	The applicant exhibits the skill to:
CA.X.A.S1	Recognize an engine failure, maintain control, use manufacturer's memory item procedures, and use appropriate emergency procedures.
CA.X.A.S2	Set the engine controls, identify and verify the inoperative engine, and feather the appropriate propeller.
CA.X.A.S3	Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required.
CA.X.A.S4	Attempt to determine and resolve the reason for the engine failure.
CA.X.A.S5	Secure the inoperative engine and monitor the operating engine and make necessary adjustments.
CA.X.A.S6	Restart the inoperative engine using manufacturer's restart procedures.
CA.X.A.S7	Maintain altitude ±100 feet or minimum sink rate if applicable, airspeed ±10 knots, and selected headings ±10°.
CA.X.A.S8	Complete the appropriate checklist(s).

3.3.2 IX.E Engine Failure During Takeoff Before VMC (Simulated) (AMEL, AMES)

References:	*FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; FAA-P-8740-66; POH/AFM*
Objective:	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with engine failure during takeoff before minimum controllable airspeed (VMC).
Note:	*See Appendix 2: Safety of Flight and Appendix 3: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.*
Knowledge:	The applicant demonstrates understanding of:
CA.IX.E.K1	Factors affecting minimum controllable speed (VMC).
CA.IX.E.K2	VMC (red line) and best single-engine rate of climb airspeed (VYSE) (blue line).
CA.IX.E.K3	Accelerate/stop distance.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.IX.E.R1	Potential engine failure during takeoff.
CA.IX.E.R2	Configuring the airplane.
CA.IX.E.R3	Distractions, task prioritization, loss of situational awareness, or disorientation.
Skills:	The applicant exhibits the skill to:
CA.IX.E.S1	Close the throttles smoothly and promptly when a simulated engine failure occurs.
CA.IX.E.S2	Maintain directional control and apply brakes (AMEL), or flight controls (AMES), as necessary.

3.3.3 IX.F Engine Failure After Liftoff (Simulated) (AMEL, AMES)

References:	*FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; FAA-P-8740-66; POH/AFM*
Objective:	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with engine failure after liftoff.
Note:	*See Appendix 2: Safety of Flight and Appendix 3: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.*
Knowledge:	The applicant demonstrates understanding of:
CA.IX.F.K1	Factors affecting minimum controllable speed (VMC).
CA.IX.F.K2	VMC (red line), VYSE (blue line), and safe single-engine speed (VSSE).
CA.IX.F.K3	Accelerate/stop and accelerate/go distances.
CA.IX.F.K4	How to identify, verify, feather, and secure an inoperative engine.
CA.IX.F.K5	Importance of drag reduction, including propeller feathering, gear and flap retraction, the manufacturer's recommended control input and its relation to zero sideslip.
CA.IX.F.K6	Simulated propeller feathering and the evaluator's zero-thrust procedures and responsibilities.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.IX.F.R1	Potential engine failure after lift-off.
CA.IX.F.R2	Collision hazards.
CA.IX.F.R3	Configuring the airplane.
CA.IX.F.R4	Low altitude maneuvering, including stall, spin, or controlled flight into terrain (CFIT).
CA.IX.F.R5	Distractions, task prioritization, loss of situational awareness, or disorientation.
Skills:	The applicant exhibits the skill to:
CA.IX.F.S1	Promptly recognize an engine failure, maintain control, and use appropriate emergency procedures.
CA.IX.F.S2	Establish VYSE; if obstructions are present, establish best single-engine angle of climb speed (VXSE) or VMC +5 knots, whichever is greater, until obstructions are cleared. Then transition to VYSE.
CA.IX.F.S3	Reduce drag by retracting landing gear and flaps in accordance with the manufacturer's guidance.
CA.IX.F.S4	Simulate feathering the propeller on the inoperative engine (evaluator should then establish zero thrust on the inoperative engine).
CA.IX.F.S5	Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required.
CA.IX.F.S6	Monitor the operating engine and aircraft systems and make adjustments as necessary.
CA.IX.F.S7	Recognize the airplane's performance capabilities. If a climb is not possible at VYSE, maintain VYSE and return to the departure airport for landing, or initiate an approach to the most suitable landing area available.
CA.IX.F.S8	Simulate securing the inoperative engine.
CA.IX.F.S9	Maintain heading ±10° and airspeed ±5 knots.
CA.IX.F.S10	Complete the appropriate checklist(s).

Chapter 4

Normal Procedures

Refer to aircraft checklists for detailed procedures. The procedures listed below should be memorized and chair-flown until familiar.

4.1 Takeoff

Takeoff briefing – GIVEN (see Emergency Procedures)

Taxi into position on the runway for takeoff

Brakes – APPLY AND HOLD

Throttles – 20 MP

Engine Gauges – CHECK IN THE GREEN

Brakes – RELEASE

Throttles – FULL

Airspeed Indicator – CHECK ALIVE

Rotate at 80 KIAS

Gear Up (when positive rate of climb)

Climb at 90 KIAS

4.2 Climb

At 500' AGL:

Throttles – 25" MP

Propellers – 2500 RPM

Cruise climb at 100 KIAS

Turn Crosswind or Depart, as Required

If staying in the pattern, at pattern altitude:

Throttles – 20” MP

Propellers – 2400 RPM

4.3 Approach to Landing

Before reaching midfield:

Power – 20” MP / 2400 RPM or as required for 100 KIAS

Gas: Fuel Selectors – ON; Aux Pumps – ON

Undercarriage – DOWN BELOW 140 KIAS

Mixtures – SET (max available power)

Propellers – 2400 UNTIL FINAL

Cowl Flaps – CLOSED

Seat Belts – FASTENED

Abeam the numbers:

Throttles – 15” MP

Flaps – ID, VERIFY, 10 DEGREES (3 SEC.)

Pitch – HALF GROUND / HALF SKY

Airspeed – 100 KIAS

Base leg:

Gear Indicators – 3 GREEN

Flaps – ID, VERIFY, 20 DEGREES (2 SEC.)

Airspeed – 95 KIAS

Power – AS REQUIRED

On final approach (left-to-right flow check):

Gear Indicators – 3 GREEN

Propellers – FULL FORWARD

Mixtures – FULL FORWARD

Flaps – FULL (DN)

Windsock – CHECK

Airspeed – 85 UNTIL SHORT FINAL

Over the threshold – CONFIRM 3 GREEN

4.4 Touch and Go

Touch and go landings are to be performed only with a Pilot's Choice Instructor!

On the runway:

Flaps – IDENTIFIED (wait for instructor to call VERIFIED) and RETRACTED

Cowl Flaps – OPENED

Throttles – ADVANCE FOR TAKEOFF *All Available Power*

4.5 Go-Around

CRAM Power - FULL *All Available Power*

CLIMB Climb at 85 KIAS (V_{yse})

CLEAN Flaps – RETRACT ABOVE 71 KIAS

.... Landing Gear – RETRACT AT 85 AND POSITIVE RATE OF CLIMB

COOL Cowl Flaps - OPEN

CALL Intentions - ANNOUNCE

4.6 VFR Approach Airspeeds and Power Settings

4.6.1 Traffic Pattern

	Airspeed	MP/RPM	Flaps/Configuration
DOWNWIND	**110**	**20"/2400**	**0**
Abeam NUMBERS	**100**	**15"/2400**	**10° (3 seconds)**
BASE	**100**	**15"/2400**	**20° (2 seconds)**
FINAL	**90**	**12-15"/High RPM**	**Full flaps (optional)**
Over NUMBERS	**85**	**12-15"/High RPM**	**Full flaps (optional)**

4.6.2 Take Off and Climb Out

	Airspeed	MP/RPM	Flaps/Configuration
ROTATION	**80**	**Max/High RPM**	**0**
CLIMB	**90 (V_{yse} or faster)**	**25"/2500**	**0 / Gear up: positive rate, no runway.**

4.6.3 Single-Engine Pattern

	Airspeed	MP/RPM	Flaps/Configuration
DOWNWIND	**85+**	**As Required/2600**	**None.**
NUMBERS	**85+**	**20"/2600**	**As Required.**
BASE	**85+**	**17-20"/2600**	**As Required.**
FINAL	**85**	**Reduce/2600**	**20º (for training)**

***GEAR & FLAPS DOWN ONLY WHEN LANDING IS ASSURED!**

Memory aid: Gear Mandatory - Do Early. Flaps Optional - Do Late.

WARNING!

DO NOT ATTEMPT A ONE-ENGINE INOPERATIVE GO-AROUND AFTER FLAPS HAVE BEEN FULLY EXTENDED!

4.7 Instrument Approach Procedures

Memory aid: Recall that VSI depends on ground speed.

4.7.1 Precision Approach, Two Engines

Airspeed	MP/RPM	Configuration	VSI
110	**18”/2400**	**Gear down @ Glide slope**	**-500**

4.7.2 Precision Approach, Single Engine

Airspeed	MP/RPM	Configuration	VSI
110	**23”/2500**	**Gear down @ Glide slope**	**-500**

4.7.3 Non-Precision Approach, Two Engines

Airspeed	MP/RPM	Configuration	VSI
110	**15”/2400 @ FAF**	**Gear down @ FAF**	**-1000**
110	**18”/2400 @ MDA**	**No change**	**0**

4.7.4 Non-Precision Approach, Single Engine

Airspeed	MP/RPM	Configuration	VSI
110	**15”/2500 @ FAF**	**Clean**	**-1000**
110	**22”/2500 @ MDA**	**Gear down landing assured**	**0**

4.7.5 Holding Pattern

Airspeed	MP/RPM	Configuration	VSI
110	**18”/2400**	**Clean**	**0**

Chapter 5

Performance

All of the following charts have been included for instructional purposes only.
Please refer to POH for all calculations of performance.

There are two types of charts available for the Duchess that many students are unfamiliar with. A description of these two follows. The rest of the charts are standard.

5.1 Accelerate-Stop Distance Defined

Accelerate-stop distance is the distance required to accelerate to decision speed (71 KIAS for the Duchess) and brake to a complete stop in the event an engine failure occurs at decision speed. It's important to realize that accelerate-stop speed is determined by factory test pilots with prior knowledge of where the failure is to occur. Therefore, the distances given in the performance charts should be considered the absolute best-case scenario.

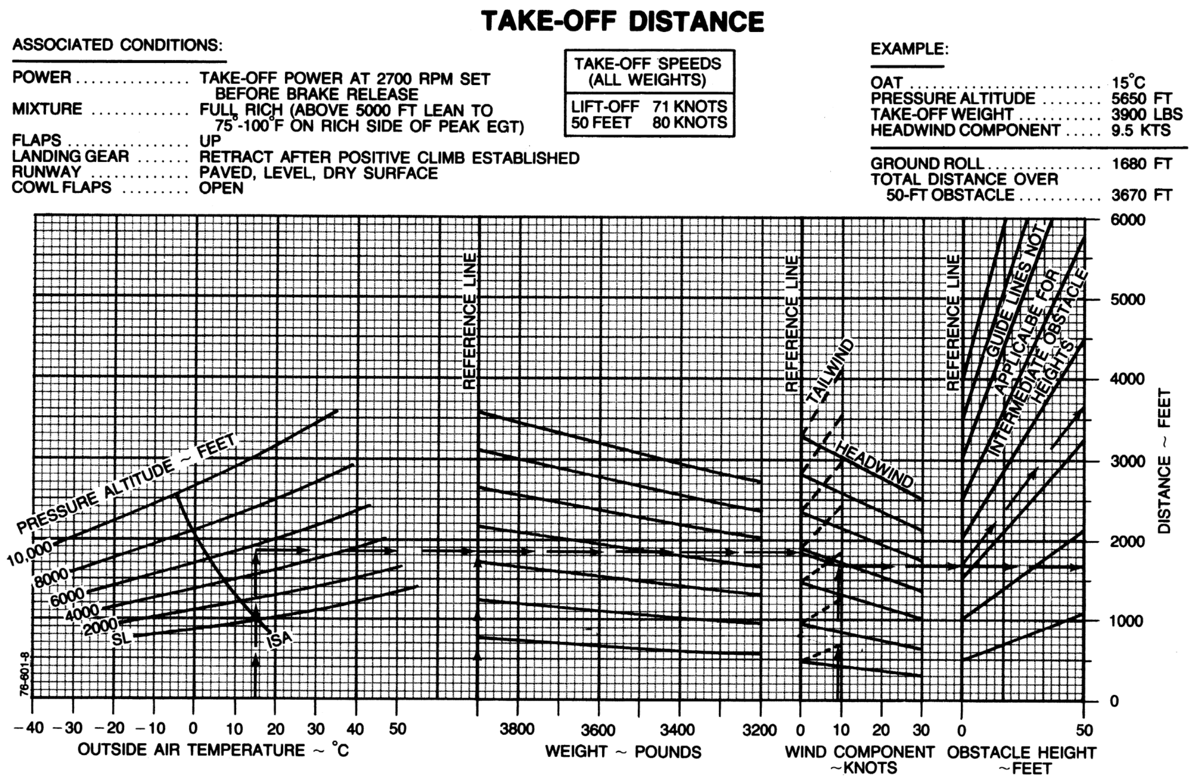
5.2 Accelerate-Go Distance Defined

Accelerate-go distance is the distance required to accelerate to decision speed (71 KIAS for the Duchess) and to continue the takeoff and clear a 50 FT obstacle in the event an engine failure occurs at decision speed. An accelerate-go distance is only applicable if the airplane can get airborne under the prevailing conditions (weight, density altitude); single-engine climb performance may not be possible with the gear down.

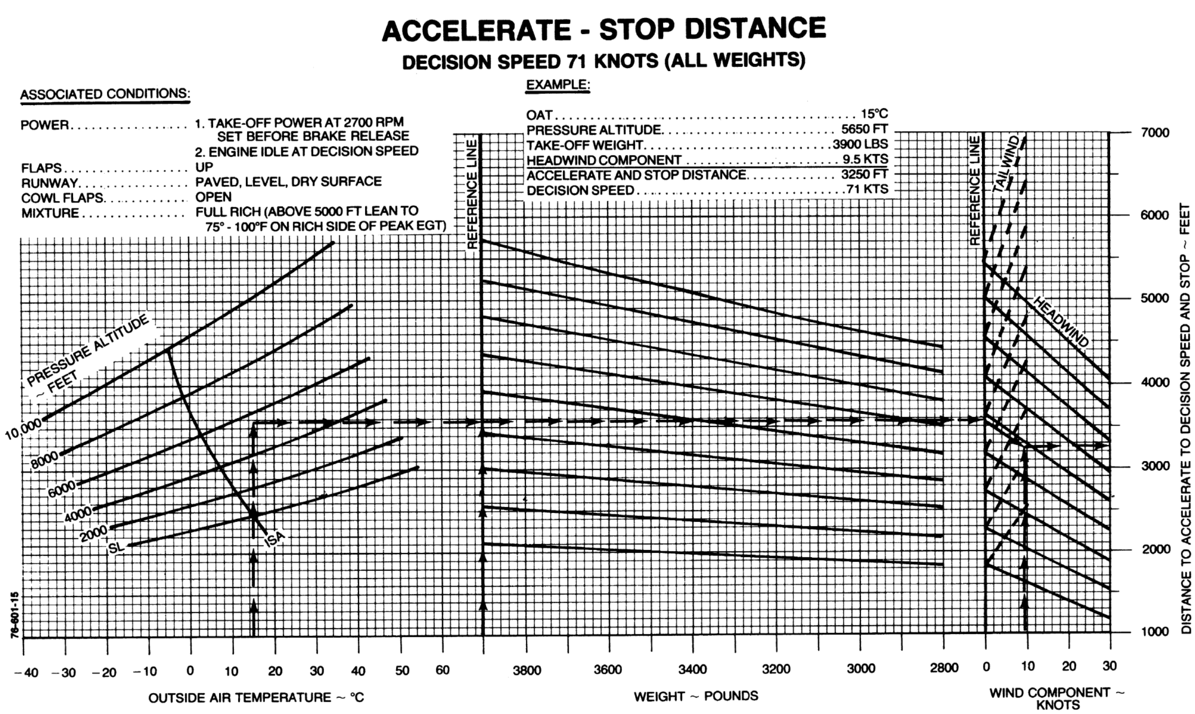
As with accelerate-stop distance, accelerate-go distance figures are determined by factory test pilots with prior knowledge of where the failure is to occur. Regard the distances given in the performance charts as the absolute best-case scenario.

Memory aid: Any weight 3,600 lbs or more is always a no-go! Do an accelerate-stop instead.

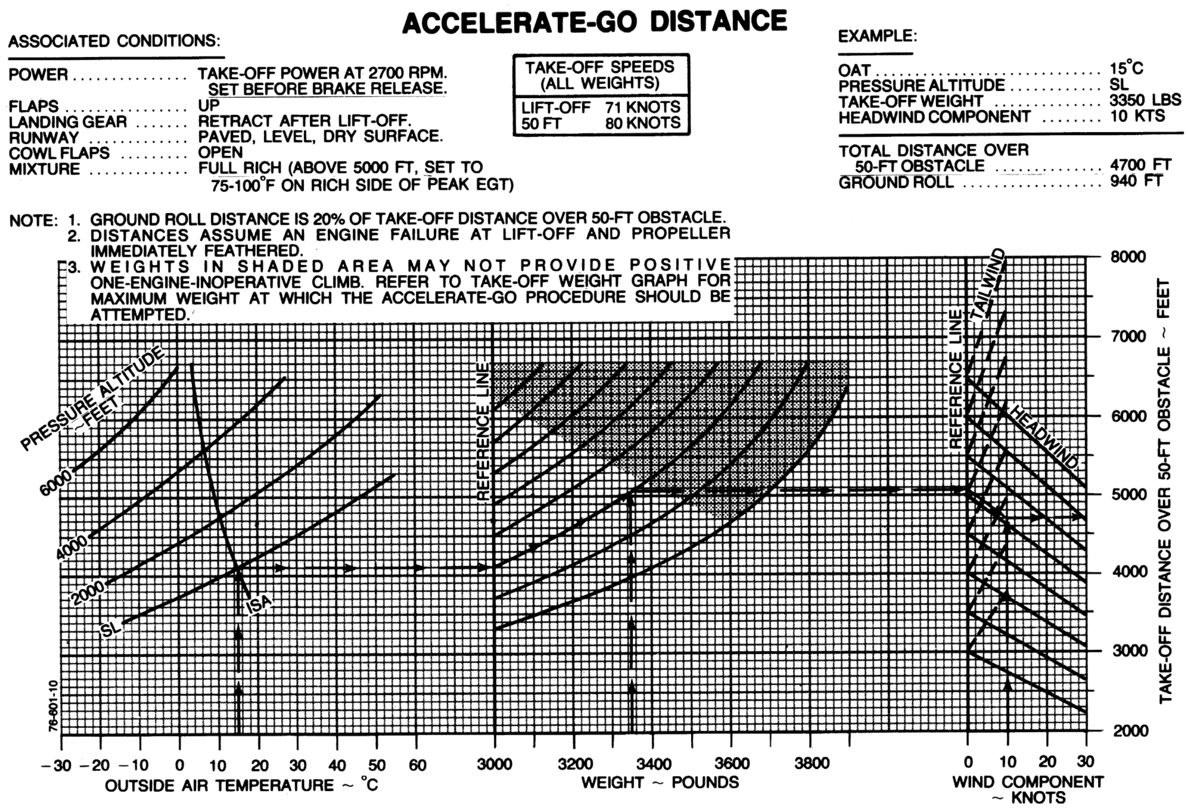
5.3 Takeoff Distance



5.4 Accelerate-Stop Distance



5.5 Accelerate-Go Distance



5.6 Two-Engine Climb Rate

CLIMB - TWO ENGINE

CLIMB SPEED 85 KNOTS (ALL WEIGHTS)

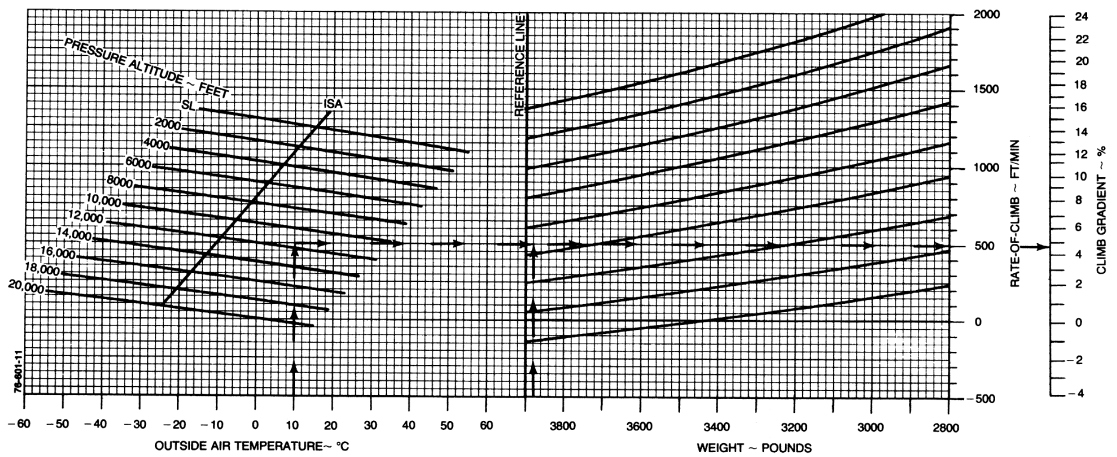
ASSOCIATED CONDITIONS:

POWER.................. MAXIMUM CONTINUOUS AT 2700 RPM
FLAPS.................. UP
LANDING GEAR.......... UP
COWL FLAPS............ OPEN
MIXTURE .... FULL RICH (ABOVE 5000 FT LEAN TO 75° - 100°F ON RICH SIDE OF PEAK EGT)

EXAMPLE:

OAT.......................................10°C
PRESSURE ALTITUDE.......................11,500 FT
WEIGHT..................................3880 LBS

RATE OF CLIMB............................500 FT/MIN
CLIMB GRADIENT 4.6%



5.7 Single-Engine Climb Rate

CLIMB - ONE ENGINE INOPERATIVE

CLIMB SPEED 85 KNOTS (ALL WEIGHTS)

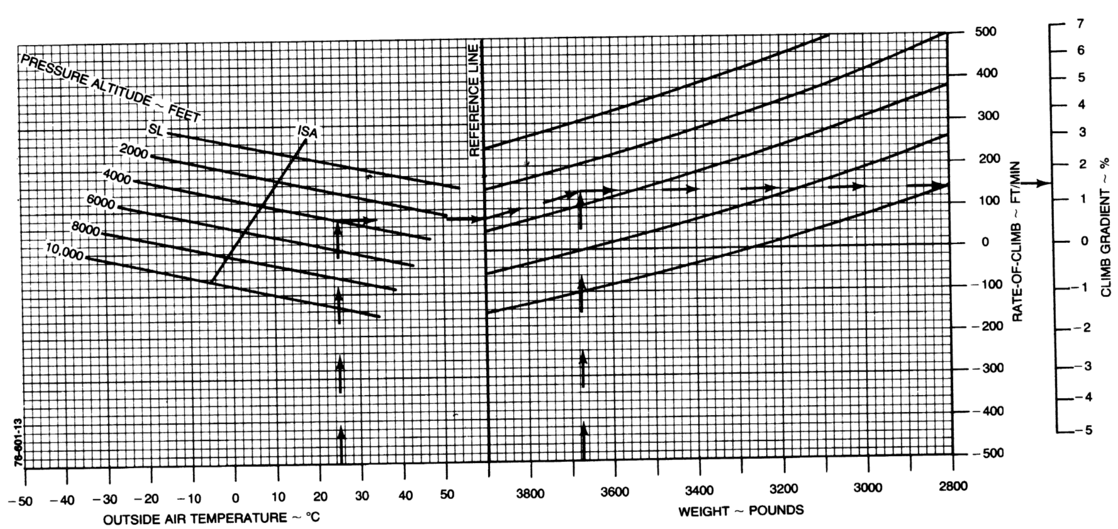
ASSOCIATED CONDITIONS:

POWER.................. TAKE-OFF AT 2700 RPM
LANDING GEAR........... UP
FLAPS.................. UP
INOPERATIVE PROPELLER · FEATHERED
COWL FLAPS............. OPEN
MIXTURE .... FULL RICH (ABOVE 5000 FT LEAN TO 75° - 100°F ON RICH SIDE OF PEAK EGT)

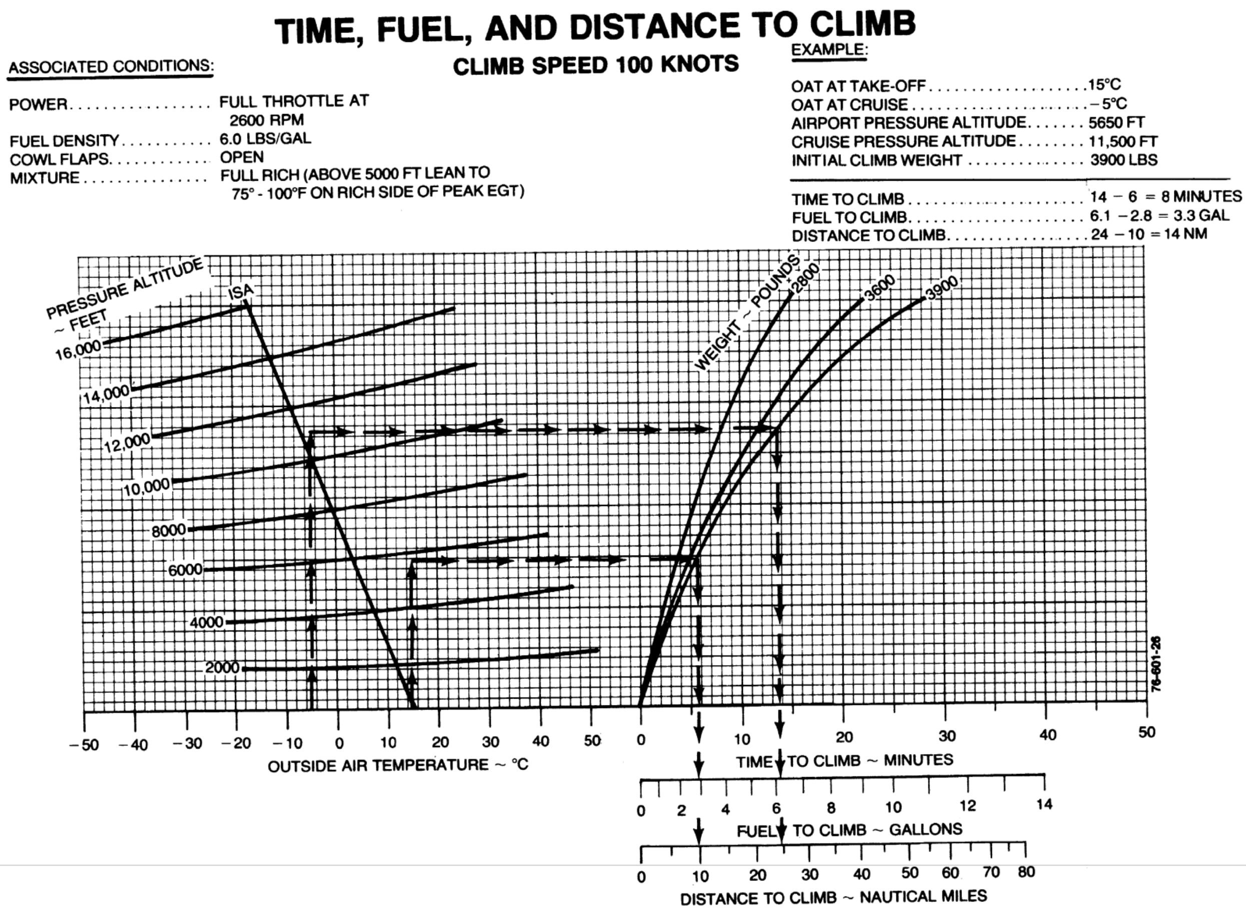
EXAMPLE:

OAT.......................................25°C
PRESSURE ALTITUDE......................3965 FT
WEIGHT..................................3677 LBS

RATE OF CLIMB............................140 FT/MIN
CLIMB GRADIENT 1.5%
CLIMB SPEED.............................85 KTS



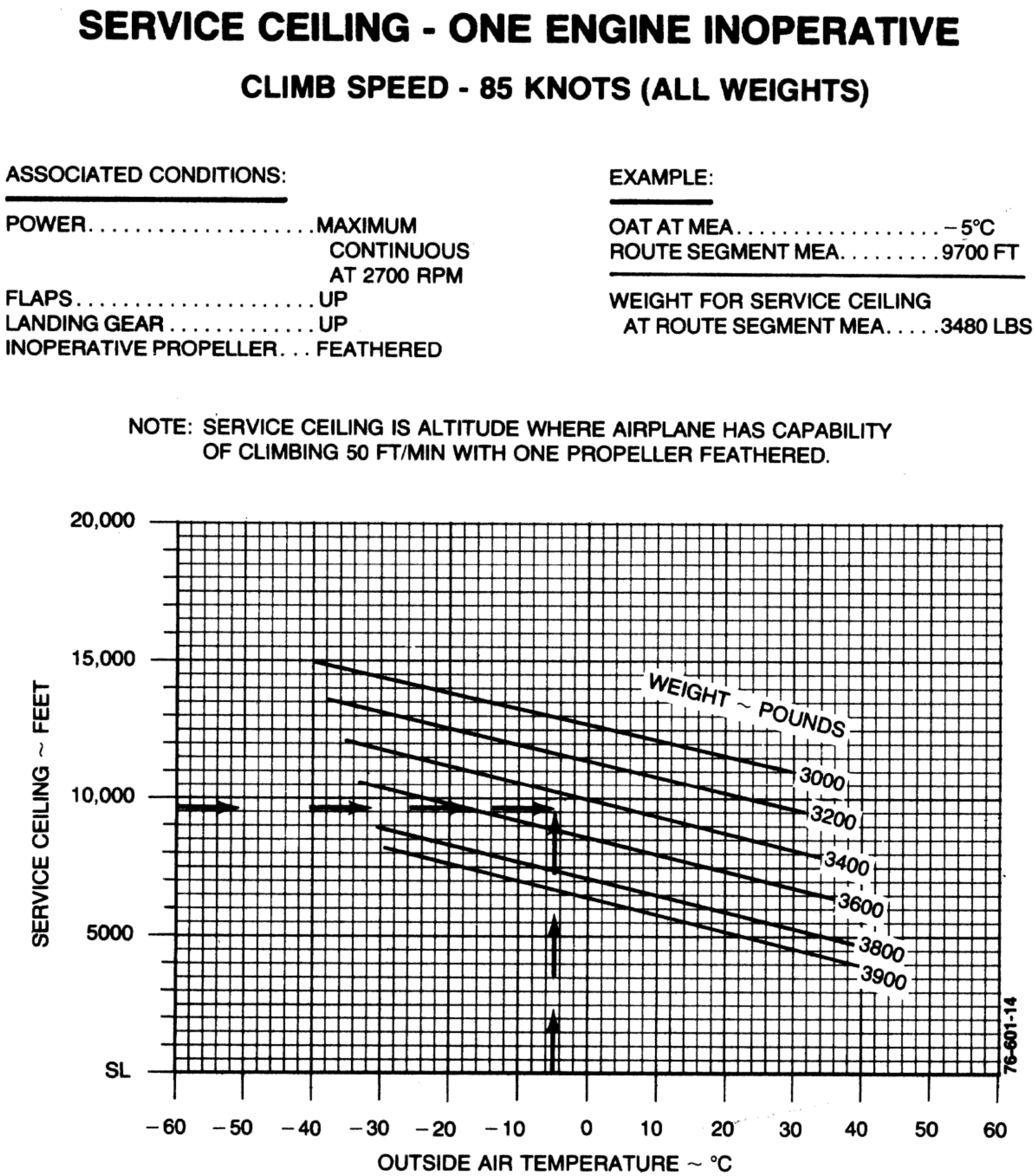
5.8 Time, Fuel, and Distance to Climb



Memory aid:

	min	gal	nmi
	T	F	D
4500	3.5	1.9	6
GTU	0.2	0.1	1
climb	3	1.8	5

5.9 Single-Engine Service Ceiling



5.10 Cruise Performance, 24” Hg

RECOMMENDED CRUISE POWER - 24.0 IN. HG @ 2300 RPM (OR FULL THROTTLE)

PRESS ALT	ISA −20°C (−36°F)							STANDARD DAY (ISA)							ISA +20°C (+36°F)						
	IOAT		MAN. PRESS	FUEL FLOW/ ENGINE		IAS	TAS	IOAT		MAN. PRESS	FUEL FLOW/ ENGINE		IAS	TAS	IOAT		MAN. PRESS	FUEL FLOW/ ENGINE		IAS	TAS
FEET	°C	°F	IN.HG	PPH	GPH	KTS	KTS	°C	°F	IN.HG	PPH	GPH	KTS	KTS	°C	°F	IN.HG	PPH	GPH	KTS	KTS
SL	-3	27	24.0	55	9.2	147	142	17	63	24.0	53	8.8	143	143	37	99	24.0	51	8.5	139	144
1000	-5	23	24.0	56	9.3	147	144	15	59	24.0	54	9.0	143	145	35	95	24.0	52	8.7	139	146
2000	-7	19	24.0	57	9.5	148	147	13	55	24.0	55	9.2	143	148	33	91	24.0	53	8.8	139	149
3000	-9	16	24.0	58	9.7	148	149	11	52	24.0	56	9.3	144	150	31	88	24.0	54	9.0	139	151
4000	-11	12	24.0	59	9.8	148	152	9	48	24.0	57	9.5	144	153	29	84	24.0	55	9.2	140	153
5000	-13	9	24.0	60	10.0	148	154	7	45	24.0	58	9.7	144	155	27	81	24.0	56	9.3	140	156
6000	-15	5	23.7	61	10.2	148	156	5	41	23.7	59	9.8	144	157	25	77	23.7	57	9.5	140	158
7000	-17	1	22.8	59	9.8	145	155	3	37	22.8	57	9.5	141	156	23	73	22.8	55	9.2	137	157
8000	-19	-2	21.9	57	9.5	142	154	1	34	21.9	55	9.2	138	155	21	70	21.9	53	8.8	134	156
9000	-21	-6	21.1	55	9.2	139	153	-1	30	21.1	53	8.8	135	154	19	66	21.1	51	8.5	131	155
10,000	-23	-9	20.3	53	8.8	136	152	-3	27	20.3	51	8.5	132	153	17	63	20.3	49	8.2	127	154
11,000	-25	-13	19.5	51	8.5	133	151	-5	23	19.5	49	8.2	129	152	15	59	19.5	47	7.8	124	152
12,000	-27	-17	18.8	49	8.2	130	150	-7	19	18.8	47	7.8	125	151	13	55	18.8	46	7.7	121	151
13,000	-29	-20	18.0	47	7.8	127	148	-9	16	18.0	46	7.7	122	149	11	52	18.0	44	7.3	117	149
14,000	-31	-24	17.3	45	7.5	123	147	-11	12	17.3	44	7.3	119	147	9	48	17.3	42	7.0	114	147
15,000	-33	-27	16.7	44	7.3	120	145	-13	9	16.7	42	7.0	115	145	7	45	16.7	41	6.8	110	144
16,000	-35	-31	16.0	42	7.0	116	143	-15	5	16.0	40	6.7	111	143	5	41	16.0	39	6.5	106	142

NOTES: 1. Full throttle manifold pressure settings are approximate.
2. Shaded area represents operation with full throttle.
3. Lean to 25° - 50°F on rich side of peak EGT.
4. Cruise speeds are presented at an average weight of 3600 lbs.

5.11 Cruise Performance, 20” Hg

RECOMMENDED CRUISE POWER - 20.0 IN. HG @ 2300 RPM (OR FULL THROTTLE)

PRESS ALT.	ISA −20°C (−36°F)							STANDARD DAY (ISA)							ISA +20°C (+36°F)						
	IOAT		MAN. PRESS.	FUEL FLOW/ ENGINE		IAS	TAS	IOAT		MAN. PRESS	FUEL FLOW/ ENGINE		IAS	TAS	IOAT		MAN. PRESS	FUEL FLOW/ ENGINE		IAS	TAS
FEET	°C	°F	IN.HG	PPH	GPH	KTS	KTS	°C	°F	IN.HG	PPH	GPH	KTS	KTS	°C	°F	IN.HG	PPH	GPH	KTS	KTS
SL	-4	25	20.0	41	6.8	127	122	16	61	20.0	40	6.7	123	123	36	97	20.0	38	6.3	119	123
1000	-6	21	20.0	42	7.0	128	125	14	57	20.0	41	6.8	124	126	34	93	20.0	39	6.5	120	126
2000	-7	19	20.0	43	7.2	129	128	13	55	20.0	42	7.0	125	129	33	91	20.0	40	6.7	121	129
3000	-9	16	20.0	44	7.3	130	131	11	52	20.0	42	7.0	126	132	31	88	20.0	41	6.8	122	132
4000	-11	12	20.0	45	7.5	131	134	9	48	20.0	43	7.2	127	135	29	84	20.0	42	7.0	122	135
5000	-13	9	20.0	46	7.7	131	136	7	45	20.0	44	7.3	127	137	27	81	20.0	43	7.2	123	137
6000	-15	5	20.0	47	7.8	132	139	5	41	20.0	45	7.5	128	140	25	77	20.0	44	7.3	124	140
7000	-17	1	20.0	48	8.0	133	142	3	37	20.0	46	7.7	128	143	23	73	20.0	45	7.5	124	143
8000	-19	-2	20.0	49	8.2	133	145	1	34	20.0	47	7.8	129	145	21	70	20.0	46	7.7	125	146
9000	-21	-6	20.0	50	8.3	134	147	-1	30	20.0	48	8.0	129	148	19	66	20.0	47	7.8	125	149
10,000	-23	-9	20.0	51	8.5	134	150	-3	27	20.0	49	8.2	130	151	17	63	20.0	48	8.0	125	151
11,000	-25	-13	19.5	51	8.5	133	151	-5	23	19.5	49	8.2	129	152	15	59	19.5	47	7.8	124	152
12,000	-27	-17	18.8	49	8.2	130	150	-7	19	18.8	47	7.8	125	151	13	55	18.8	46	7.7	121	151
13,000	-29	-20	18.0	47	7.8	127	148	-9	16	18.0	46	7.7	122	149	11	52	18.0	44	7.3	117	149
14,000	-31	-24	17.3	45	7.5	123	147	-11	12	17.3	44	7.3	119	147	9	48	17.3	42	7.0	114	147
15,000	-33	-27	16.7	44	7.3	120	145	-13	9	16.7	42	7.0	115	145	7	45	16.7	41	6.8	110	144
16,000	-35	-31	16.0	42	7.0	116	143	-15	5	16.0	40	6.7	111	143	5	41	16.0	39	6.5	106	142

NOTES: 1. Full throttle manifold pressure settings are approximate.
2. Shaded area represents operation with full throttle.
3. Lean to 25° - 50°F on rich side of peak EGT.
4. Cruise speeds are presented at an average weight of 3600 lbs.

5.12 Landing Distance

LANDING DISTANCE - FLAPS DOWN (DN)

APPROACH SPEED 76 KNOTS (ALL WEIGHTS)

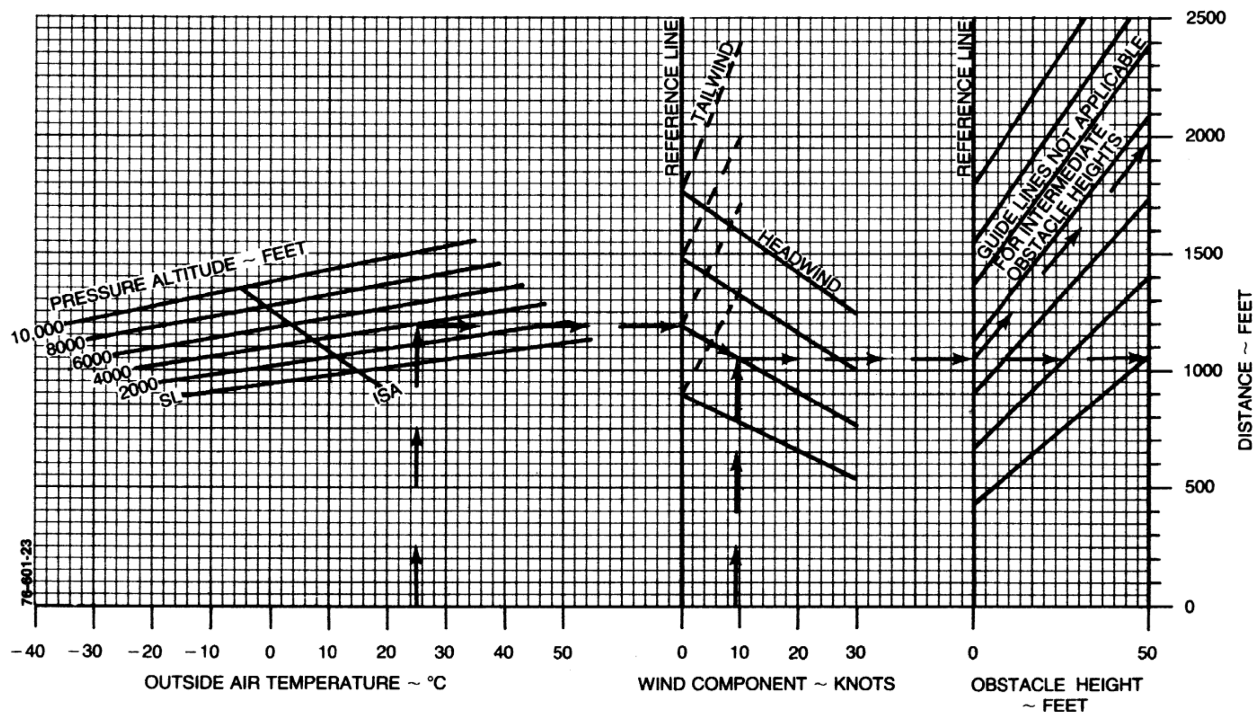
ASSOCIATED CONDITIONS:

POWER............ RETARD TO MAINTAIN 600 FT/MIN ON FINAL APPROACH
FLAPS............ DOWN (DN)
LANDING GEAR..... DOWN
RUNWAY........... PAVED, LEVEL, DRY SURFACE
APPROACH SPEED.. 76 KNOTS IAS
BRAKING.......... MAXIMUM

EXAMPLE:

OAT.. 25°C
PRESSURE ALTITUDE........................ 3965 FT
HEADWIND COMPONENT........................ 9.5 KTS

GROUND ROLL.............................. 1050 FT
TOTAL OVER 50 FT OBSTACLE................. 1970 FT
APPROACH SPEED............................ 76 KTS



Chapter 6

Weight and Balance

Calculation of weight and balance in the Duchess is straightforward. Note that the Duchess has a maximum zero fuel weight, which restricts the useful load carried as passengers and cargo. The maximum weight of the airplane plus passengers and baggage must not exceed 3500 pounds – the rest of the useful load must be carried as fuel.

See the figures available in the POH for information on loading arms and C.G. limits.

	Weight	**x Arm**	**= Moment**
Basic Empty Condition			
Pilot & Front Passengers		105 (forward) 112 (aft)	
Passengers – Row 2		144	
Baggage (200# max)		167	
Zero Fuel Weight (3500# max)			
Fuel		117	
Ramp Condition			
Start/Taxi/Takeoff			
Takeoff Condition (3900# max)			
Load Adjustments:			
Front seat		105 (forward) 112 (aft)	
Passenger		144	
Baggage		167	
Fuel		117	
New Takeoff Weight (3900# max)			
Fuel Burn		117	
Landing Condition			

Chapter 7

Systems - Beechcraft Duchess BE-76

Memory aid: N6001Y ME-119; N3733G ME-364

7.1 Engines

The Duchess has two Lycoming 4 cylinder-engines – an O360 on the left, and an LO-360 (the "L" is for "left" turning) on the right. Both engines produce 180 horsepower at 2700 RPM and are air-cooled, direct drive, horizontally opposed, reciprocating, normally aspirated engines. Oil capacity is 8 quarts maximum.

7.2 Propellers

7.2.1 Propeller System Basics

The Duchess has two 76-inch diameter, constant speed, full-feathering Hartzell propellers. The propellers are counter-rotating: the left propeller turns clockwise and right propeller turns counter-clockwise. Unlike most light twins which have conventional propellers where both turn clockwise, there is no critical engine with counter- rotating propellers. See the definition of critical engine in Section 1.

The propeller controls on the control console allow the pilot to select the governor's RPM range. Propeller governors regulate oil pressure to control RPM by varying the blade angle (pitch) of the propeller to make it more efficient. Oil pressure and aerodynamic twisting send the propeller out of feather to high RPM settings (low pitch=small blade angle, taking small "bites" of air). Nitrogen pressure and a large spring, aided by counterweights, send the propeller to low RPM (high pitch=high blade angle).

The oil pressure and nitrogen/spring pressure constantly oppose each other. When the propeller control is moved to the feather position, the opposing oil pressure is released and the spring, air pressure and counterweights cause the propeller to "feather" - a pitch of approximately 80°; this is a minimum drag condition. The propellers can be unfeathered with the aid of unfeathering accumulators. When the propeller control is moved forward, stored oil pressure is released which forces the propeller into a lower pitch. If this is done above 100 knots, the propeller should windmill, allowing the engine to be re-started without the aid of the starter.

A feathering lock, operated by centrifugal force, prevents feathering during engine shut down by making it impossible to feather any time the engine speed falls below 950 RPM. For this reason, when the pilot wishes to feather a propeller, he must be sure to move the propeller control into the FEATHER position before the engine speed drops below 950 RPM. This will not happen while airborne since the propeller will windmill faster than 950 RPM with normal propeller control settings. *(see schematic)*

7.2.2 Propeller Governor Operation

The propeller governor is mounted on the accessory case on the rear of the engine. It contains a speeder spring, which is directly controlled by the propeller lever in the cockpit, and flyweights which spin at engine RPM (see propeller system diagram). When the pilot sets an RPM value with the propeller control, the engine attempts to maintain that RPM setting by pitching the blades as required by the existing airspeed and power setting.

The propeller governor operates by regulating the flow of high-pressure oil into and out of the propeller hub. Increasing oil pressure into the hub pitches the propeller blades flatter (higher RPM) and allowing oil to flow out of the propeller hub allows the propeller to achieve a higher pitch (lower RPM or feather). The flow of oil is controlled by a pilot valve in the governor which blocks the flow of oil to and from the propeller hub under normal conditions.

When the propeller RPM starts to increase (because of a momentary dive, for example) the flyweights are slung away from the rotating shaft because of centrifugal force. This raises the shaft, which allows oil to flow from the propeller hub to the oil sump, moving the blades to higher pitch and reestablishing the set RPM value. When the propeller RPM starts to decrease, the counterweights have less centrifugal force slinging them away from the shaft, and the speeder spring forces them inward. This moves the pilot valve in the opposite direction, which allows the flow of high-pressure oil into the propeller hub, moving the blades to a flatter position and increasing RPM to the set value.

At lower power settings and airspeeds, the propellers may be fully flat and RPM will decrease below the set value. At this point, moving the propeller control fully forward will have no effect on engine RPM, since the blades are already at their flattest pitch.

Memory aid: This is why the throttles change RPM when at idle.