Five x Five Flight Aviation Training

BE76 Duchess
Multi-Engine Study Guide

2971 Hawthrone Dr
Conroe, Tx 77301

Tel: (832) 257-6600
www.fivexfiveflight.com/

June 2025

The Five x Five Flight Aviation Training Multi-Engine Study Guide is for reference only and is intended only to supplement, not replace, manufacturer and FAA publications such as the Pilot's Operating Handbook. All pilots must operate the aircraft in accordance with the Pilot's Operating Handbook and abide by Federal Aviation Regulations.

Contents

Section 1:
Engine-out Aerodynamics

TURNING TENDENCIES

The turning tendencies that affect a single engine aircraft (p-factor, torque, spiraling slipstream, gyroscopic precession) will also affect a multi-engine aircraft. Because a multi-engine aircraft has two engines many of these turning tendencies increase.

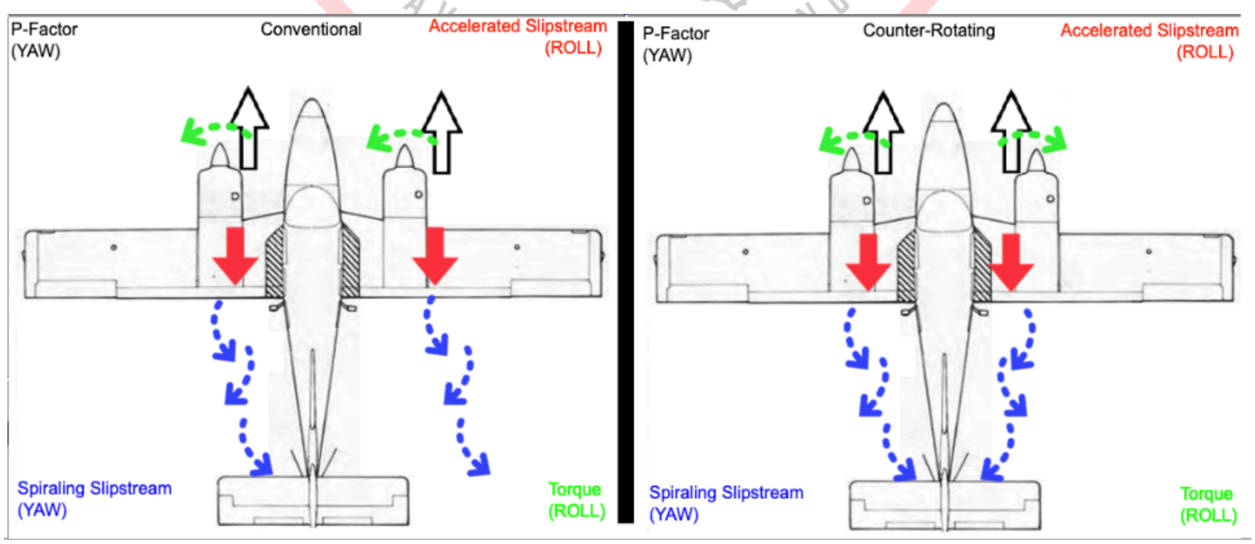
A twin engine aircraft where both engines are rotating the same direction is called a **conventional twin**. To combat p-factor and torque, aircraft with **counter-rotating** propellers have been developed (the BE76 Duchess has counter-rotating propellers). The p-factor and torque from counter-rotating propellers cancel each other out which results in less rudder needed to oppose their turning tendencies.

CRITICAL ENGINE

A **critical engine** is the engine which, if lost, will most adversely affect the performance and handling characteristics of the aircraft (14 CFR § 1.1). The effect of the critical engine is most significant when the aircraft is operating at low airspeed with a high power setting (thus more p-factor and torque).

On a **conventional twin** with both propellers rotating clockwise, the critical engine is the **left** engine. On an aircraft with **counter-rotating** propellers, such as the BE76 Duchess, there is **not a critical engine** because the yawing and rolling caused from losing either engine is identical. There are four factors which determine if an engine is critical (PAST):

1. P-Factor
2. Accelerated Slipstream
3. Spiraling Slipstream
4. Torque



WHAT HAPPENS WHEN AN ENGINE FAILS?

Two things happen when an engine fails: Yaw and Roll towards the dead engine because now lift, thrust, and drag act on the aircraft asymmetrically.

1. **Yaw** - Asymmetrical thrust, with an increased arm distance on the right engine, due to **P-factor**, will cause a yawing motion around the C.G. toward the inoperative engine.
2. **Roll** - Induced flow (**Accelerated Slipstream**- extra lift created by accelerated air over the wing) from the operating engine and lack of induced flow from the inoperative engine causes asymmetric lift on wings. This results in a rolling moment around the C.G. towards the inoperative engine.
3. **Yaw** – Due to the lack of **Spiraling Slipstream** acting on the vertical stabilizer from the left engine being inoperative, the operating right engine yaw causes an increased yaw towards the inoperative engine.
4. **Roll** – For every action, an equal and opposite reaction must occur. **Torque** from the right engine spinning clockwise, causes the aircraft to roll left towards the inoperative engine.

To counteract this roll and yaw, rudder pressure must be applied to the side of the operational engine to oppose these forces. Hence, "**Dead foot- Dead engine**".

V_{MC}- VELOCITY MINIMUM CONTROL

Definition: minimum control speed with the critical engine inoperative (14 CFR § 1.1)

Rudder is applied to counteract yaw and roll from an inoperative engine in a multi-engine aircraft. As airspeed decreases the rudder becomes less effective, eventually an airspeed will be reached where full rudder deflection is required to maintain directional control. At this point, any further airspeed reduction will result in a loss of directional control. This airspeed is Vmc, the lowest calibrated airspeed at which it is still possible to maintain directional control with an engine inoperative.

Minimum Control Speed (*14 CFR § 23.149*)

$\underline{V_{MC}}$ is the calibrated airspeed, at which, when the critical engine is suddenly made inoperative it is possible to*:*

1. Maintain control of the airplane with the engine still inoperative
2. Maintain straight flight at the same speed with an angle of bank not more than 5 degrees.

The method used to simulate critical engine failure must represent the most critical mode of powerplant failure expected in service with respect to controllability. V_{MC} must not exceed 1.2 V_{S1} at maximum takeoff weight.

V_{MC} must be determined with **(SMACFUM)**:

1. **S**tandard Day (15C and 29.92 in hg, at sea level)
2. **M**ost unfavorable weight (not necessarily max gross weight)
3. Most unfavorable center of gravity position (**A**ft CG)
4. All propeller controls in the recommended takeoff position (**C**ritical engine windmilling)
5. **F**laps in the takeoff position, Landing gear retracted, cowl flaps open
6. **U**p to 5 degrees of bank towards the operating engine
7. **M**aximum available takeoff power initially on each engine

When recovering from V_{MC}:

1. The rudder pedal force required to maintain control must not exceed 150 pounds
2. It must not be necessary to reduce power of the operative engine(s)
3. The airplane must not assume any dangerous attitude
4. It must be possible to prevent a heading change of more than 20 degrees

A note on regulations for how V_{MC} is determined: For normal category airplanes, such as the Duchess, 14 CFR § 23 provides the regulations for aircraft type certification. In 2016, 14 CFR § 23 was rewritten to a performance-based philosophy, removing the previous design-based philosophy. The 2016 update, which only applies to aircraft type certified after it was published, now only provides performance and safety standards manufacturers must meet for type certification. This essentially removed the "how" of aircraft design/certification and allows manufacturers to use new and different methods and technologies to design and build aircraft. Consequently, 14 CFR § 23.149 was removed and replaced with 14 CFR § 23.2135 (c), which simply states the applicant must determine V_{MC} for the most critical configurations used during takeoff and landing. While not required by letter of the regulation, manufacturers are still likely using conditions found in SMACFUM to determine V_{MC} as it is the most critical configuration. AC 23-8C, Section 4, provides guidance on the testing process to determine V_{MC}.

RECOGNIZING AND RECOVERING FROM V_{MC}

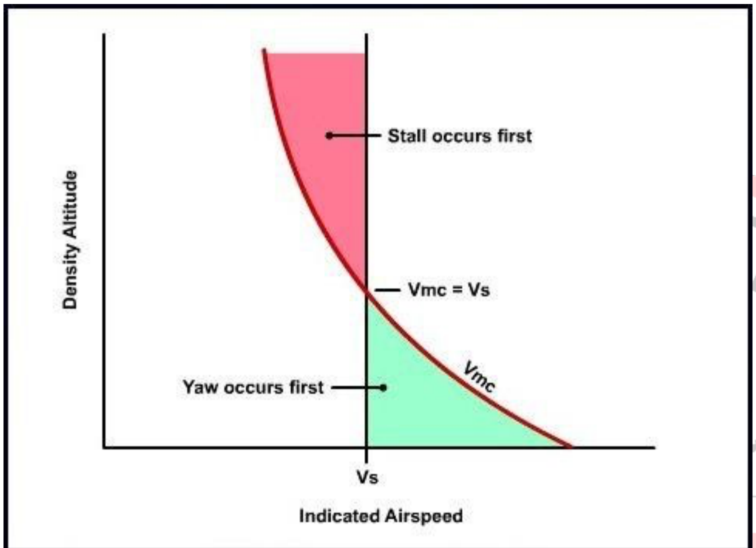
There are four warning signs that V_{MC} is occurring or about to occur:

1. **Loss of directional control**- the rudder pedal is depressed to its fullest travel and the airplane is still turning towards the inoperative engine
2. **Stall warning horn-** a single engine stall may be just as dangerous as running out of rudder authority and could even result in a spin
3. **Buffeting before the stall-** same reason as the stall warning horn
4. **A rapid decay of control effectiveness-** any loss of control effectiveness could result in a loss of control of the aircraft

To recover from V_{MC}, these two actions **must occur simultaneously**:

1. **Reduce power on the operating engine-** this will reduce the asymmetrical thrust causing the V_{MC} in the first place (remember, reducing power all the way to idle may help stop the V_{MC}, but the loss of airspeed and power can lead to a stall)
2. **Pitch down-** lowering the nose of the airplane will increase the forward airspeed making the rudder more effective in regaining and maintaining directional control

V_{MC} AND IT'S RELATIONSHIP TO STALL SPEED



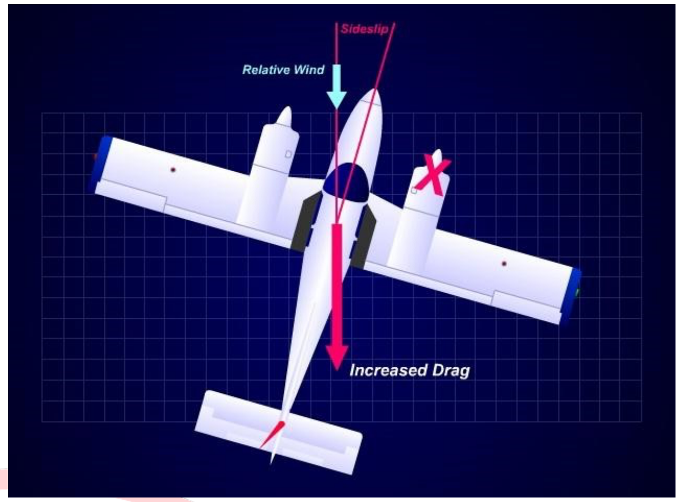
As density altitude increases, V_{MC} speed will decrease because as density altitude increases engine power will decrease (less engine power at higher density altitude→ less asymmetric thrus→ less yaw towards dead engine= lower V_{MC}). Stall speed is an indicated airspeed which will remain constant as altitude increases or decreases. Spins are likely when stalling and V_{MC} is lower than V_S.

FACTORS AFFECTING V_{MC} AND SINGLE ENGINE PERFORMANCE

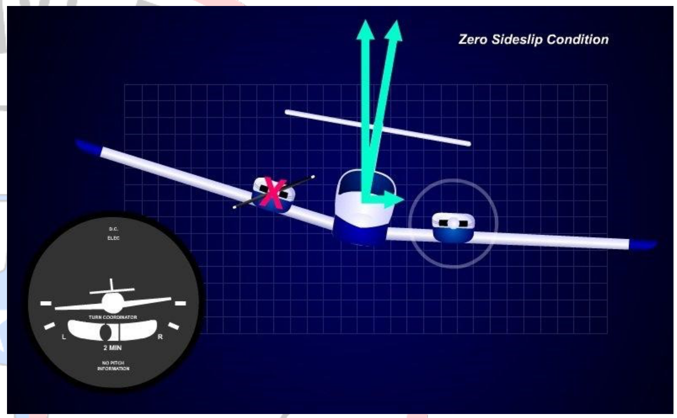
V_{MC} is defined using a very specific set of conditions, thus published V_{MC} and actual V_{MC} can be two very different numbers. Remember, V_{MC} only addresses directional control and is not related to aircraft performance. While controllability is important, the degradation of performance in a single engine situation also has serious consequences. A variety of factors affect both controllability and performance with one engine inoperative, such as aircraft configuration, flight conditions, and pilot action. In some cases, an element which provides an increase in controllability (translating into a decrease in V_{MC}) may actually hinder performance. Refer to the chart on the next page to review how certain factors affect both V_{MC} and performance.

EFFECT ON	V_{MC}	PERFORMANCE
Power Increase	**Up**- more yaw	**Up-** more power
Temp Increase	**Down**- less dense, less power, less yaw	**Down-** less dense, less power
Pressure Decrease	**Down**- less dense, less power, less yaw	**Down-** less dense, less power
Density Altitude Increase	**Down**- less dense, less power, less yaw	**Down**- less dense, less power
Bank Angle- 0 bank- no turn	**Up**- sideslip plane- less AOA on rudder because of sideslip airflow- less rudder effectiveness- more rudder needed	**Down**- more drag- slipping
Bank Angle- 5 bank- no turn	**Down**- plane turning toward good engine + rudder used to stop turn = slip toward good engine- high AOA on rudder	**Down**- more drag- slipping
Windmilling Propeller	**Up**- more drag, more yaw	**Down-** more drag
Feathered Propeller	**Down**- less drag, less yaw	**Up**- less drag
Aft CG	**Up**- less distance between rudder and CG- less rudder effectiveness	**Up**- less tail down force required less induced drag; Down- smaller arm on controls, less control effectiveness
Heavier Weight	**Down**- more lift needed in level flight- more horizontal lift available during turn- helps prevent turn	**Down**- more weight, more power required
Flaps Down	**Down**- more induced drag from good engine side prevents yaw towards dead engine	**Down**- more airflow over flap causes greater drag, increased yaw, increased roll, requiring more aileron to stop, creating more adverse yaw= more induced drag
Gear Down	Depends on location of CG to gear and direction of travel (Vmc down, keel effect)	**Down**- more parasitic drag
Critical Engine Fails	**Up**- P-factor, Accelerated Slipstream, Torque makes yaw worse	**Down**- larger control inputs
In Ground Effect	**Up**- less drag- more thrust available- more yaw	**Up**- less drag

ZERO SIDESLIP CONDITION



The solution to maintaining aircraft heading and reducing drag is to improve performance using the **Zero Sideslip Condition.** When the aircraft is banked into the operating engine (2-5 degrees of bank), the dihedral of the wing will create a horizontal component of lift. The horizontal component of lift minimizes rudder deflection required to align the longitudinal axis of the aircraft to the relative wind. In addition to banking into the operating engine, the appropriate amount of rudder required is indicated by the inclinometer ball being "split" towards the operating engine's side. The zero sideslip condition must be flown for optimum aircraft performance.



CLIMB PERFORMANCE AND SERVICE CEILING

Climb performance is dependent on the excess power needed to overcome drag. When a twin-engine airplane loses an engine, the airplane loses 50% of its available power. This power loss results in a loss of approximately 80% of the aircraft's excess power and climb performance. Drag is a major factor relative to the amount of excess power available. An increase in drag (such as the loss of one engine) must be offset by additional power. This additional power is now taken from the excess power, making it unavailable to aid the aircraft in the climb. When an engine is lost, maximize thrust (full power) and minimize drag (flaps and gear up, feather prop, etc) in order to achieve optimum single engine climb performance. Drag Factors:

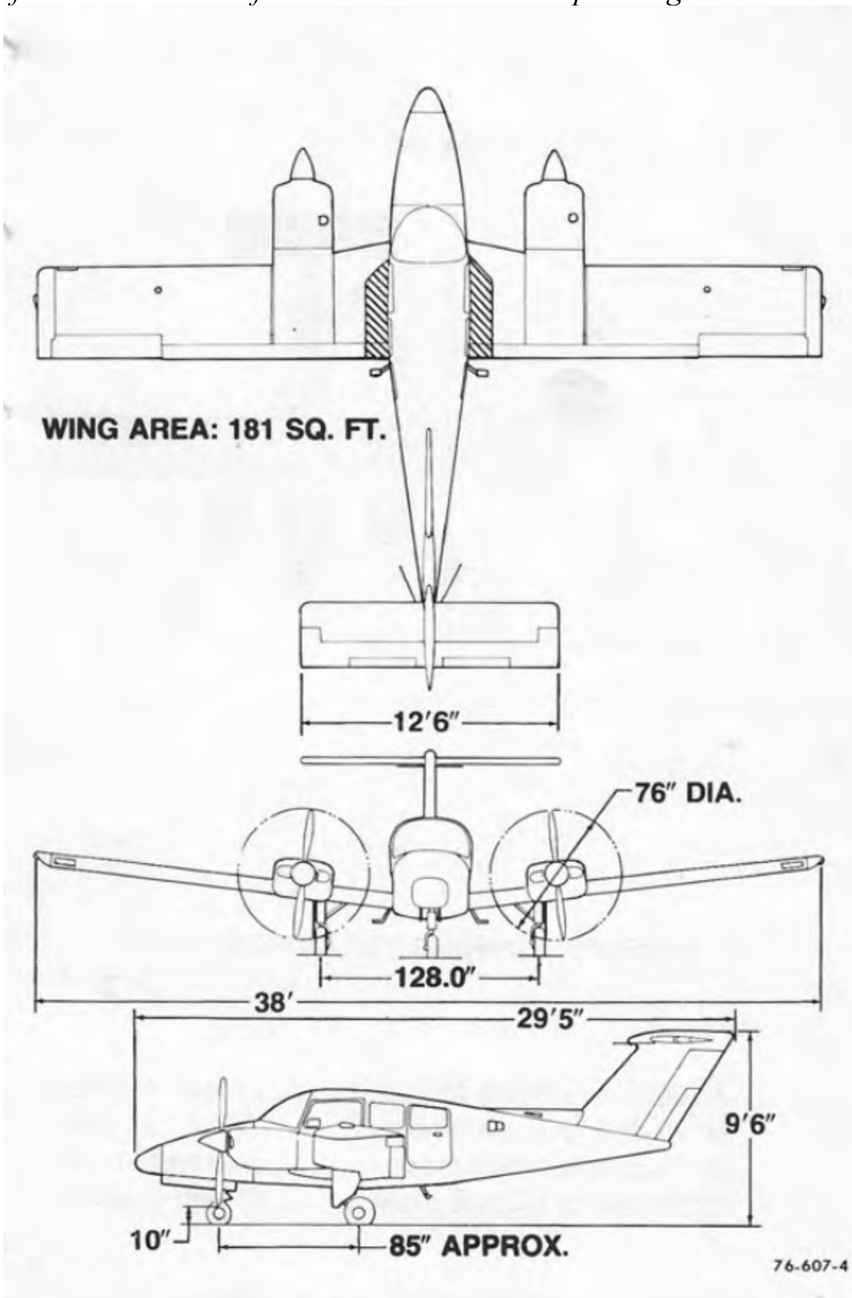
1. Full Flaps- ~400 fpm approx.
2. Windmilling Prop- ~400 fpm approx.
3. Gear Extended- ~150 fpm approx.

Single-engine service ceiling- the highest altitude at which the airplane can maintain a steady rate of climb of 50 fpm with one engine operating at full power and one engine's propeller feathered

Single-engine absolute ceiling- the altitude where climb is no longer possible with one engine operating at full power and one engine's propeller is feathered

Section 2:
Aircraft Systems and Limitations

This study guide is only to supplement the aircraft POH, not to replace it. Refer to aircraft POH for official operating limitations and systems information. It is the pilot's responsibility to be familiar with all information in the Pilots Operating Handbook.



THREE-VIEW

V-SPEEDS (KIAS)

V_R	Rotation Speed	71
V_X	Best Angle Climb	71
V_{XSE}	Best Angle 1 Engine	85
V_Y	Best Rate Climb	85
V_{YSE}	Best Rate 1 Engine	85
V_{SO}	Stall w/ Flaps	60
V_{S1}	Stall w/o Flaps	70
V_{MC}	Min Control 1 Engine	65
V_A	Maneuvering (3000lb)	116
V_A	Maneuvering (Max Gross)	132
V_{NO}	Max Structural Cruise	154
V_{NE}	Never Exceed	194
V_{SSE}	1 Engine Intentional	71
V_{LR}	Max Gear Retraction	112
V_{LE}/V_{LO}	Max Gear Operation Speed	140
V_{FE}	Flap Extension (<20)	120
V_{FE}	Flap Extension (full)	110
Best Glide	3000lb	82
Best Glide	Max Gross	95
X-Wind	Max Demonstrated	25

MAXIMUM CERTIFICATED AND STANDARD AIRCRAFT WEIGHTS

Maximum Ramp Weight	3916lbs
Maximum Take-off Weight	3900lbs
Maximum Landing Weight	3900lbs
Maximum Zero Fuel Weight	3500lbs
Maximum Weight in Baggage Compartment	200lbs
Standards Empty Weight	2653lbs
Maximum Useful Load	1247lbs

CENTER OF GRAVITY

Forward Limits: 106.6 in aft of datum at 3240 lbs and under, then straight line variation to 110.6 in aft of datum at a weight of 3900 lbs.
Aft Limit: 117.5 in aft of datum at all weights. Datum reference: 129.37 in forward of the center of wing spar jacks.

MANEUVERS

This is a normal category airplane. Aerobatic maneuvers, including spins, are prohibited.

Maximum Slip Duration	30 seconds

LOAD FACTORS (3900 lbs)

Positive maneuvering load factors:

Flaps Up	3.8G
Flaps Down (DN)	2.0G

Negative Maneuvering load factor:

Flaps Up	~1.52G

KINDS OF OPERATION

Minimum Flight Crew	1 Pilot

1. VFR day and night
2. IFR day and night
3. FAR part 91 operations when all pertinent limitations and performance considerations are complied with

Warning: Flight into known icing conditions prohibited.

ENGINES

Two Avco Lycoming Engines are installed; one O-360-A1G6D (clockwise rotating) located on the left wing and one LO-360-A1G6D (counterclockwise rotating) located on the right wing. The engines are four-cylinder, direct drive, horizontally opposed, and each rated at 180 horsepower at 2700 rpm. The engines use a wet sump pressure type oil system with a maximum of 8 qts and a minimum of 5 qts.

The engine is equipped with a carburetor heat system which allows heated unfiltered air to enter the induction system to alleviate the possibility of induction ice. Cowl flaps are controlled by levers inside the cockpit; they allow the amount of engine cooling air to be controlled to maintain a desired cylinder head temperature. Engine ignition is provided through a dual engine driven magneto system which is independent of the electric system (if electrical power is lost, engine will continue to run).

Each engine is equipped with a fuel pressure gauge, oil pressure, oil temperature, cylinder head temperature, manifold pressure, rpm, and exhaust gas temperature.

Take-off and Max Continuous Power	Full Throttle, 2700rpm
Maximum Oil Temp	245 F
Maximum Cylinder Head Temp	500 F
Minimum Oil Pressure (idle)	25 psi

Minimum Oil Pressure	100 psi
Minimum Fuel Pressure	0.5 psi
Maximum Fuel Pressure	8.0 psi

PROPELLERS

The airplane is equipped with two Hartzell 76 in, constant-speed, full feathering, two-blade propellers. Springs and dome air pressure, aided by counterweights, move the blades to the high pitch (feathered) position. Propeller rpm is controlled by the engine-driven propeller governor which regulates oil pressure in the hub. The propeller controls, on the control console, allow the pilot to select the governor's rpm range. Springs and dome air pressure, aided by counterweights, move the blades to high pitch. Engine oil under governor-boosted pressure moves the blades to the high rpm position.

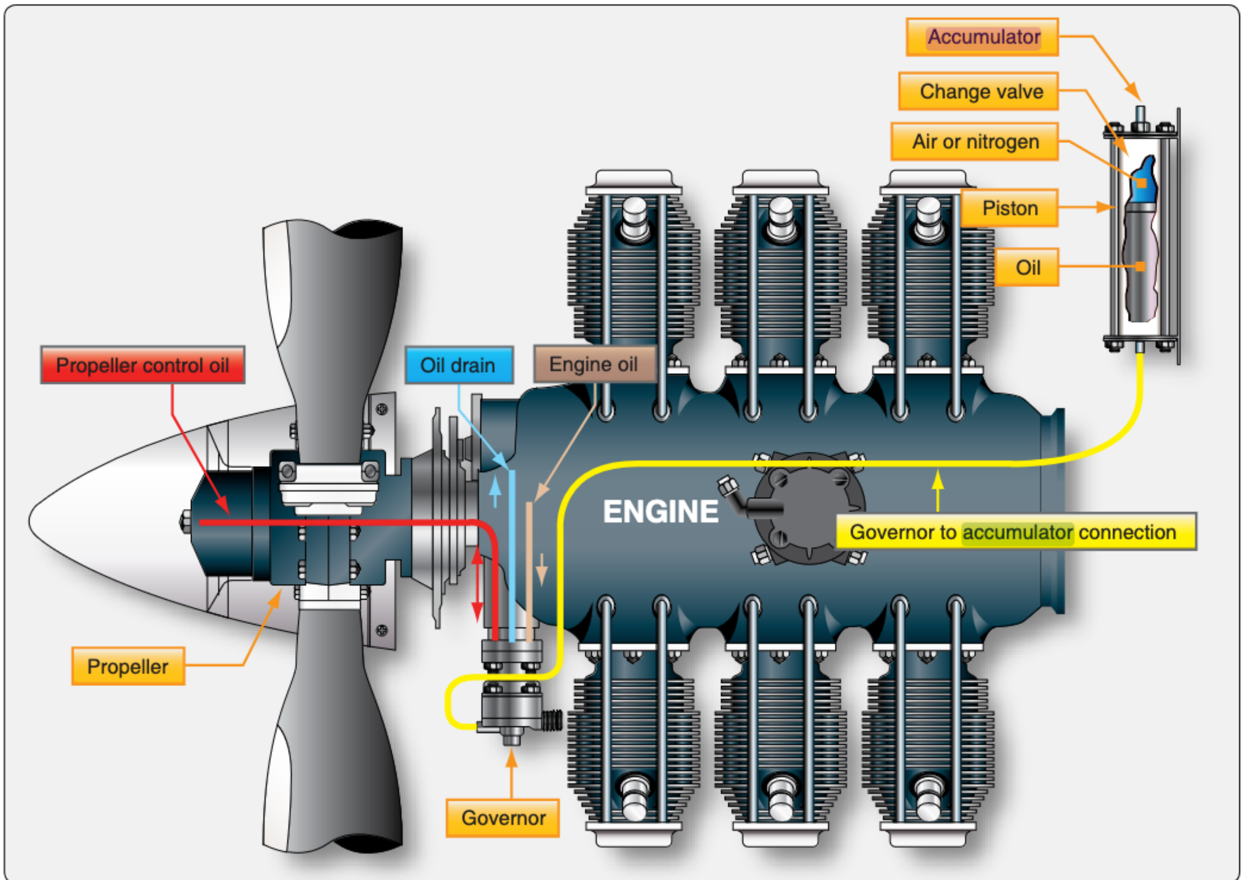
Constant Speed- is the ability to vary propeller pitch to maintain a constant engine rpm. When the propeller control is moved forward, positive oil pressure, regulated by a propeller governor, drives a piston, which rotates the blades to a low pitch high RPM (unfeathered) position. When the propeller control is moved aft, oil pressure is reduced by the propeller governor. After an rpm is selected, the prop governor will automatically adjust oil pressure inside the propeller hub. This results in a constant propeller rpm regardless of flight attitude or manifold pressure setting.

Feathering- is when the propeller blades are in alignment with relative wind. Feathering reduces the amount of drag produced by the propeller windmilling by reducing its exposed area to the relative wind. This is accomplished by moving the propeller control to the low rpm (feather) position.

The propellers should be cycled occasionally during cold weather operations. This will maintain warm oil inside the propeller hubs.

If oil pressure is lost when the engine is operating above 950rpm's (it will be in any phase of normal flight) then the propeller will automatically go into the feather position.

Unfeathering Accumulator - An accumulator is connected to the governor with a valve to trap an air-oil charge when the propeller is feathered but released to the propeller when the rpm control is returned to normal position The air or nitrogen pressure in one side of the accumulator pushes a piston to force oil from the other side of the accumulator through the governor to the propeller piston to move the propeller blades from feather to a lower blade angle. The propeller then begins to windmill and permits the engine to start.. This system is used with training aircraft because it unfeathers the propeller in a very short time and starts the engine windmilling.



FUEL

The BE76 Duchess uses aviation gasoline, grade 100 (green) or grade 100LL (blue). The fuel system is an "ON-CROSSFEED-OFF" arrangement and controlled by the fuel selectors located on the lower center floor panel. Total capacity is 51.5 gallons per wing tank with 50 gallons usable in each tank. Each wing fuel tank has a visual measuring tab with markings for 30 (28.5 useable), 40 (38.5 useable) and full at tank top.

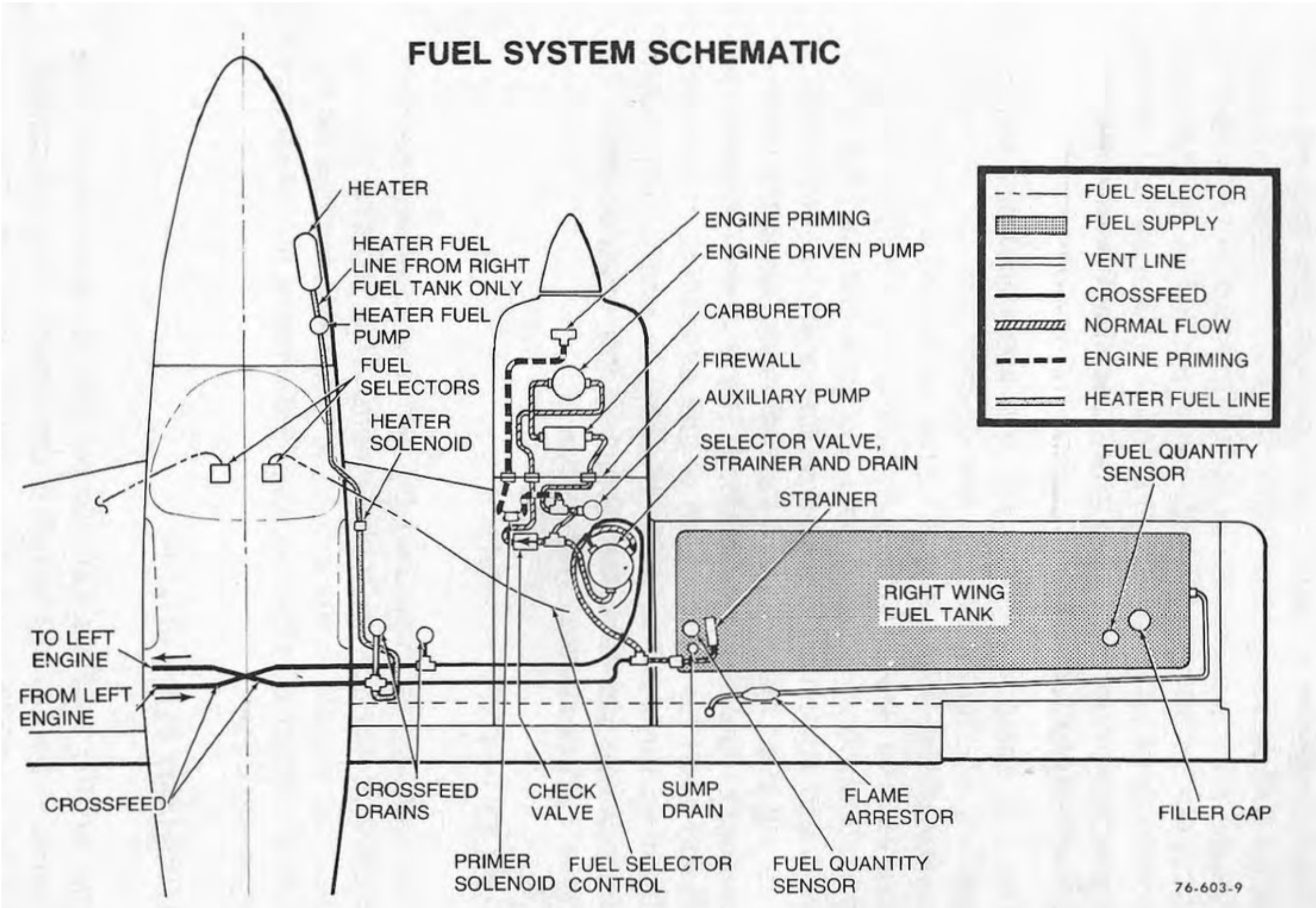
There are two engine-driven and two electrically driven auxiliary fuel pumps. The electric fuel pumps are used for engine start, takeoff, landing, and fuel selector changes. The fuel selector remains in the on position during normal operations, with each tank feeding its respective engine. Engine priming is accomplished by using the "PUSH TO PRIME" switch in accordance with normal procedures.

Fuel cannot be transferred from tank to tank, and the operative engine can only be feed from one tank at a time. The fuel selector ON position feeds from the same side the engine is on (e.g., right engine, right fuel tank), while the CROSSFEED position feeds from the opposite side. The inoperative engine fuel selector must be in the OFF position to crossfeed. The cabin heater, located in the nose compartment uses approximately 2/3 gallon per hour from the right fuel system only.

The fuel crossfeed system is to be used during emergency conditions in straight flight only.

A min of 9 gal of fuel must be present in each wing tank prior to flight.

Total Capacity	103
Total Usable	100



FLIGHT CONTROLS

The control surfaces are bearing supported and operated through the conventional cable assembly using push-rods and bell cranks.

TRIM CONTROL

Aircraft trim is accomplished using either the manual or electric pitch trim system. An emergency disconnect button will disengage the trim motor when depressed allowing time to turn off the trim circuit breaker. The aileron trim is located in the lower center console; this is used to displace the ailerons for trimming through cable tension only.

FLAPS

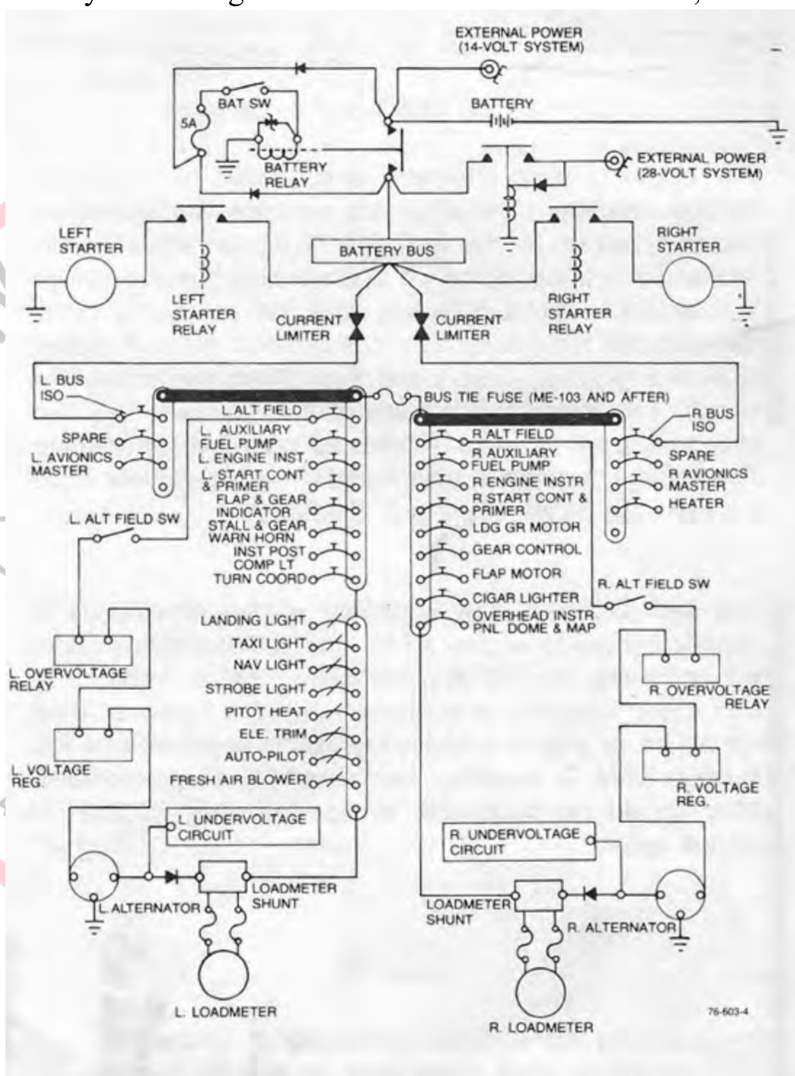
Wing flaps are operated by a three position switch with the UP, DOWN, and OFF position. The switch must be pulled out of detent in order to change position. There is an indicator gauge with UP, 10, 20, and DOWN (35). (Note: it takes 3 seconds for flaps to move from UP to 10 position, 1 second from 10 to 20, and 1 second from 20 to 35 respectively)

When flaps are positioned below 16 degrees the landing gear horn will sound if the gear is not down and locked (regardless of throttle position).

ELECTRICAL SYSTEM

Five x Five Flight's BE76 Duchess is equipped with a 24-volt, 33 ampere-hour lead-acid battery installed in a battery box in the aft fuselage compartment. Two 55 ampere, 28-volt, belt-driven alternators provide charging. The output of each alternator is controlled by a separate voltage regulator. The alternator systems are completely separate, except for the BUS TIE FUSE, the mutual tie to the battery bus through two bus isolation circuit breakers, and the paralleling circuit between regulators. The aircraft uses a split bus system with each alternator powering its respective bus. The battery is used for engine start and emergency power. Overvoltage protection is provided.

There are two loadmeters, alternator out annunciators, and under/overvoltage annunciators. The alternator out annunciator light and zero indication on the ammeter indicate an alternator failure. If one alternator fails the other alternator will provide adequate electrical power.



POWER DISTRIBUTION SCHEMATIC

LANDING GEAR

The Duchess is equipped with a tricycle gear, hydraulically actuated, fully retractable landing gear. Hydraulic pressure is provided by an electrically driven reversible hydraulic pump. There are two circuit breakers: one for the hydraulic pump, one for the control circuit. The gear is held up using hydraulic pressure and remains locked in the down position using over-center brace and spring. There is a time delay which will disengage the hydraulic pump after 30 seconds of continuous operation.

The aircraft is equipped with a gear warning system which will activate under the following conditions:

1. Gear is not in the down and locked position below apx. 16" of MP on either engine
2. Gear is not in the down and locked position with flaps extended below 16 degrees
3. Gear handle is in the up position on the ground

Gear retraction on the ground is prevented by the ground pressure safety switch located in the pitot system to deactivate the pump circuit when airspeed is below 59-63 KIAS. (It should be noted that gear warning systems are no replacement for proper checklist usage and should not be relied on to prevent an inadvertent gear up.) The gear system is equipped with a hydraulic bypass valve for manual gear extension in the event of an emergency. The valve is located beneath the floor panel in front of the pilot. By rotating the valve 90 degrees hydraulic pressure is released and the gear is lowered by gravity. This can only be accomplished below 100 KIAS and the emergency checklist should be followed. In the event that hydraulic pressure is lost with gear retracted, gear will free fall to the down position.

ENVIRONMENTAL

The BE76 Duchess is equipped with a 45,000 btu Janitrol gas heater located on the right side in the nose compartment. This provides heated air for cabin warming and windshield defrosting. Fuel consumption of the heater is approximately 2/3 gal per hour from the right fuel tank and should be considered during flight planning. Operation of the heater is controlled by a three position switch on the pilots subpanel labeled "HEATER-ON, BLOWER ONLY, OFF." The "BLOWER ONLY" position is only for ground operations. Another switch labeled "CABIN AIR- PULL OFF" controls the amount of air entering the cabin from the heater. Pulling the knob more than half closed will deactivate the heater in order to prevent overtemp. The push-pull knob labeled "CABIN TEMP- PULL TO INCREASE" controls the temperature of air entering the cabin.

Heater Operation:
1. Cabin Air Knob – Push full forward to open
2. Heater switch – Blower Only (10 seconds)
3. Heater Switch – Heater On
4. Cabin Temp Knob – Adjust as desired

Heater Shutdown:
1. Cabin Air Knob – Push full forward to open
2. Heater Switch – Blower only
3. Heater Switch – (After 2 minutes) Off
4. Cabin Temp Knob – Push full forward to close
5. Cabin Air knob – As desired

BRAKES

The Duchess has hydraulically actuated disk brakes on the main landing gear. The hydraulic system for the brakes is independent from the landing gear. The brakes are actuated by depressing the top of each respective rudder pedal. To set the parking brake, pressure must be applied to the top of the rudder pedal. The brake reservoir is located on the left side of the nose compartment.

PITOT-STATIC

The pitot tube is located on the left wing. There are two static ports on each side of the aft fuselage. There is an alternate static source located inside of the cockpit. The pitot tube is also equipped with a pitot heat system. The pitot-static system provides air pressure used for indications on the airspeed indicator, vertical speed indicator, and altimeter.

Section 3:
Performance / Weight and Balance

All performance charts will be covered by the instructor, and will include, but are not limited to the following:

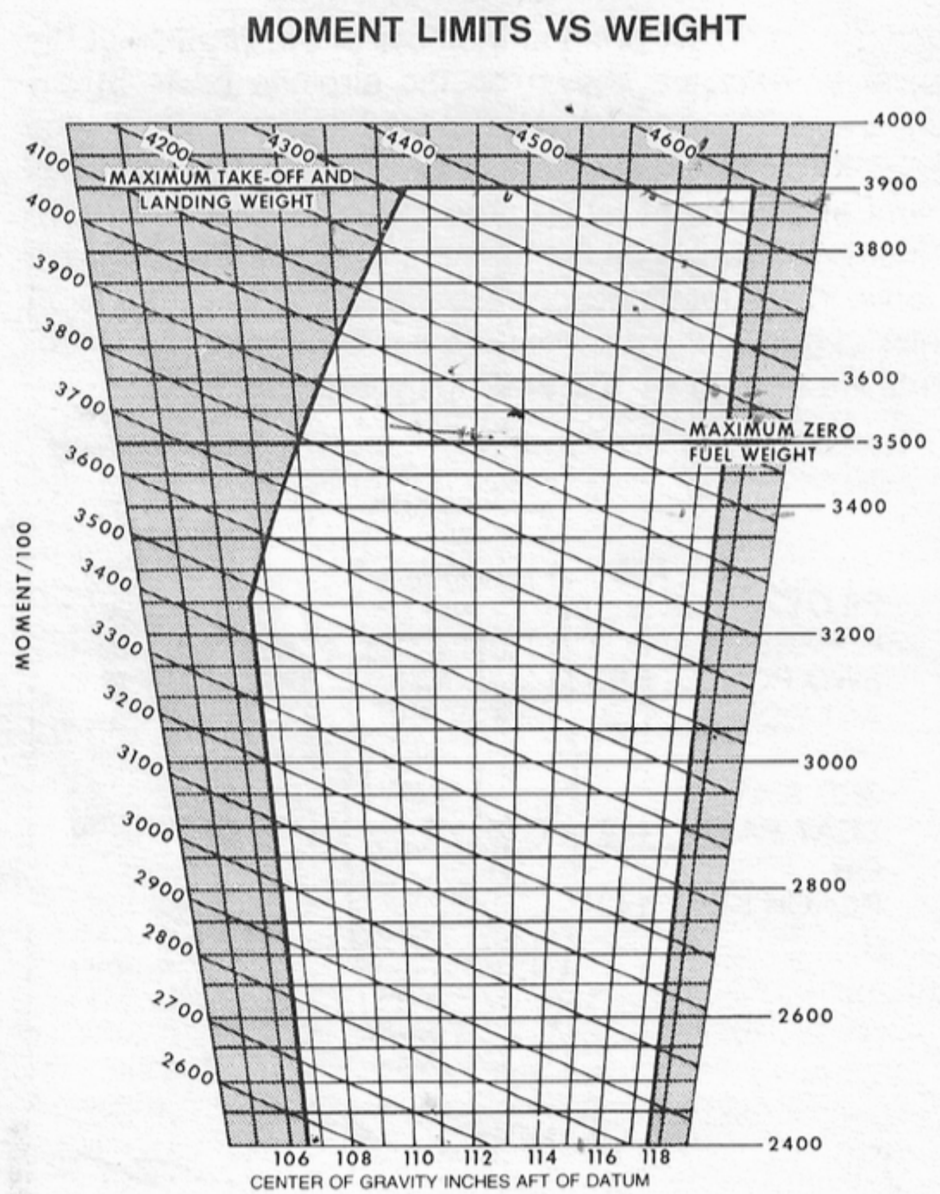
- Takeoff distance over 50 foot obstacle
- Accelerate-go distance
- Accelerate stop distance
- Two engine rate of climb
- Single engine rate of climb
- Single engine service ceiling
- Flaps up landing distance
- Landing distance over 50ft obstacle

WEIGHT/BALANCE
Basic Empty Weight: 2652.94 lbs
Maximum Ramp Weight: 3916 lbs
Maximum Takeoff Weight: 3900 lbs
Maximum Landing Weight: 3900 lbs
Maximum Zero Fuel Weight: 3500 lbs
Maximum Weight in Baggage Compartment: 200 lbs

CG Limits:
Empty CG: 110.41
Forward CG Limits – 110.6" @ 3900 lbs, 106.6" @ 3250 lbs, 106.6" @ 2400 lbs
Aft CG Limits – 117.5" @ 2400 lbs, 117.5" @ 3900 lbs

	Weight	Arm	Moment
Empty Weight	2628 lbs	110.92"	291529.19
Pilot & Front PAX		108.5"	
Rear PAX		142"	
Baggage (Max 200lbs)		167"	
Zero Fuel CG (Max 3500lbs)		CG:	
Fuel in LBS (6/GAL)		117"	
Takeoff Weight (Max 3900lbs)			
Fuel Burn		117"	
Landing Weight			
Max Gross Weight	3900 lbs		

Moment Limits Vs Weight Chart



ENVELOPE BASED ON THE FOLLOWING WEIGHT AND CENTER OF GRAVITY LIMIT DATA (LANDING GEAR DOWN)

WEIGHT CONDITION	FWD C. G. LIMIT	AFT C. G. LIMIT
3900 POUNDS (MAX. TAKE-OFF/LANDING)	110.6	117.5
3250 POUNDS OR LESS	106.6	117.5

76-601-6

Section 4: Emergency Procedures

*These are emergency **memory items only**, they do not encompass all the emergency procedures listed in the POH. In any emergency or abnormal condition, the POH should be consulted.*

The In Flight Engine Failure procedure is a memory item, and must be memorized verbatim and if called for must be completed in it's entirety without prompting.

MEMORIZE!

IN-FLIGHT ENGINE FAILURE

Directional Control	**MAINTAIN**
Airspeed	**Blue Line**
Mixtures	**Full FWD**
Props	**Full FWD**
Throttles	**Full FWD**
Flaps	**UP**
Gear	**UP**
Identify	**Dead Foot**
Verify/ Throttle	**Close (Slowly)**
Troubleshoot *"Fix or Feather"*	**If Alt Permits**
Prop (bad engine)	**Feather**
Mixture (bad engine)	**Cut Off**
Emergency Checklist	**Applicable**
Declare	**Emergency**

After going through the *in-flight engine failure flow,* a decision will be made to try to fix the dead engine or to immediately feather. (Hence, "fix or feather.") If an engine is lost below 1000ft AGL feather the prop on the dead engine. If an engine is lost above 1000ft AGL and there is sufficient time/ground clearance, "fix" and troubleshoot the dead engine. The zero sideslip condition should be established. (Hence, "raise the dead.") After going through the engine failure memory items always remember to consult the appropriate emergency checklist and declare an emergency. In all circumstances during engine failure, **MAINTAIN DIRECTIONAL CONTROL** of the aircraft.

Section 5:
Multi-Engine In-flight Maneuvers

Through study and practice, flow checks should be performed from memory. Refer to PTS for completion standards for in-flight maneuvers.

PRE-MANEUVER CHECKLIST

(Done before every maneuver)

1. Fuel Selectors - On
2. Cowl Flaps - Open
3. Mixtures – Rich
4. Propellers – High RPM
5. Fuel pumps – On
6. Landing/Taxi Light - On

STEEP TURNS – Cruise Maneuver (120kts)

(ATP/PVT Rating-45º Bank / Commercial Rating-50º Bank)

1. Perform Clearing Turns as Required
2. Set Bug to Entry Heading
3. Set Power (20/2300)
4. Airspeed: Less than 132 KIAS
5. Perform 360º Left or Right Steep Turn
6. Roll Out within 10º of Entry Heading (ATP Maneuver Complete) For Commercial Rating:
7. Perform 360º Steep Turn Opposite Direction, Roll Out within 10º of Entry Heading
8. Cruise Checklist

SLOW FLIGHT

1. Cruise Power (24/2300)
2. Set Bug to Entry Heading
3. 90º Clearing Turn
4. Power: 15” MP (or just above gear horn sounding)
5. 90º Clearing Turn Back to Entry heading
6. Pre-maneuver checklist
7. <140 Gear down
8. Flaps: Full, in increments
9. Slow to 80 KIAS
10. Increase Power as Necessary to Maintain 80 KIAS
11. Maintain Altitude while Maneuvering
12. Full Power for Recovery
13. Maintain Altitude
14. Retract flaps to 0º
15. Accelerate to 85 KIAS (V_Y)
16. Gear Up, accelerate to 100 KIAS
17. Cruise Power (24/2300)
18. Cruise Checklist

POWER OFF STALL – Approach Stall

(ATP Rating-Recover at Stall Horn / Commercial Rating-Recover at First Indication)

1. Cruise Power (24/2300)
2. Set Bug to Entry Heading
3. 90º Clearing Turn
4. Power: 15" MP (or just above gear horn sounding)
5. 90º Clearing Turn Back to Entry Heading
6. <140 Gear down
7. Pre-maneuver checklist
8. Flaps: Full, in increments
9. ATP-Maintain Altitude/COM-Descend at 85 KIAS
10. Power: 15" MP, then idle, pitch up
11. Full Power for Recovery
12. Flaps: UP
13. Accelerate to 71 KIAS (V_X)
14. ATP-Maintain Altitude/COM-Positive Rate of Climb
15. Gear Up, Accelerate to 85 KIAS (V_Y)
16. Cruise Power (24/2300)
17. Cruise Checklist

POWER ON STALL – Departure Stall

(ATP Rating-Recover at Stall Horn/Commercial Rating-Recover at First Indication)

1. Cruise Power (24/2300)
2. Set Bug to Entry Heading
3. 90º Clearing Turn
4. Power: 15" MP (or just above gear horn sounding)
5. 90º Clearing Turn Back to Entry Heading
6. Pre-maneuver checklist
7. Slowly Pitch Up 10-12º while Increasing Power to 20" MP
8. Maintain Pitch Attitude, Slowing to Point of Recovery
9. Full Power for Recovery
10. Accelerate to 71 KIAS (V_X)
11. Positive Rate of Climb
12. Accelerate to 85 KIAS (V_Y)
13. Cruise Power (24/2300)
14. Cruise Checklist

EMERGENCY DESCENT

1. Power: Idle
2. <140 Gear down
3. G.U.M.P.P.S.S
4. Descend @ 135kts (+0/-10 kts) while banking 30 - 45º
5. Level off at specified altitude, set power ~15”
6. **<112** Gear up
7. Cruise Power (24/2300)
8. Cruise Checklist

Vmc DEMO

1. Cruise Power (24/2300)
2. Set Bug to Entry Heading
3. 90º Clearing Turn
4. Power 15” MP (or just above gear horn sounding)
5. 90º Clearing Turn Back to Entry heading
6. Pre-maneuver checklist
7. Left Throttle: Close - Maintain Heading and Altitude
8. Right Throttle: Full Power - Maintain Heading Using Up to 5º Bank towards Operating Engine
9. Pitch Up Slowly
10. Limit Rudder Input at 85 KIAS
11. Announce and Recover at First Sign of:
    a. Loss of Directional Control with Limited Rudder Input
    b. First Indication of a Stall (Stall Horn or Buffet)
12. Reduce Half Power on Operating Engine and Decrease Pitch to Regain Directional Control within 20º of Entry Heading
13. Increase Power Slowly on Operating Engine while Maintaining an AOA that allows for airspeed to increase and minimize altitude loss
14. Accelerate to 85 KIAS
    i. Bring Left and Right Throttle Together Slowly to 20” MP.
    ii. Props: 2300 RPM
15. Cruise Power (24/2300)
16. Cruise Checklist

DRAG DEMO (MEI ONLY)

(Required only for MEI Rating; Note Power Required and VSI Changes for Each Step.)

1. Cruise Power (24/2300)
2. Set Bug to Entry Heading
3. 90º Clearing Turn
4. Power 15" MP (or just above gear horn sounding)
5. 90º Clearing Turn Back to Entry heading
6. Pre-maneuver checklist
6. Slow to 85 KIAS (blueline)
7. Gear Down
8. Power: Increase to Maintain 85 KIAS and Altitude
9. Flaps: 20º
10. Power: Increase to Maintain 85 KIAS and Altitude
11. Flaps: 35º
12. Power: Increase to Maintain 85 KIAS and Altitude
13. Left Throttle: Close (Windmilling Prop)
14. Maintain Heading
15. Left Cowl Flap: Close
16. Right Throttle: Full Power to Maintain 85 KIAS
17. Flaps Up, Maintain 85 KIAS
18. Gear Up, Maintain 85 KIAS
19. Left Throttle: 12" MP (Sim. Feather), Maintain 85 KIAS
20. Pitch for 85 KIAS
21. Pitch for 100 KIAS
22. Bring Throttles Slowly Together to 20" MP
23. Left Cowl Flap: Open/As Required
24. Cruise power (24/2300)
25. Cruise Checklist

Section 7:
Flight Profiles

GUMPPSS FLOW

1. Gas (Fuel selectors) - On
2. Undercarriage - Down
3. Mixture – Full Rich
4. Propellers – High RPM
5. Pumps (Fuel) - On
6. Switches (Lights) – On
7. Seatbelts – Secure

TAKEOFF GEAR UP CONDITIONS ("Positive Rate, No Usable Runway, Gear Up")

Altimeter – Noted increasing trend OR
VSI – Positive rate of climb AND
No usable runway (Runway no longer visible under nose, No longer able to land and come to stop on runway)

NORMAL TAKEOFF / PATTERN / LANDING

1. Before entering runway – GUMPPSS Flow
2. When aligned with centerline – Increase power 2000 RPM
3. Check engine instruments
4. Advance throttle to full power
5. Rotate at V_R (71 kts)
6. Climb at V_Y (85 Kts / Blue line)
7. When positive rate, no usable runway verified – Gear Up
8. At 700' AGL set power 25" / 2500 RPM, start crosswind turn (or turn as needed if departing pattern)
9. At 1000' AGL / Pattern altitude set power 20" / 2500 RPM , turn downwind as needed
    a. If leaving pattern, maintain power at 25" / 2500 RPM, increase airspeed to 100 kts, then climb checklist
10. Midfield downwind – Check speed, if < 140 kts, Gear down
11. Abeam touchdown point (1000 ft aiming point marker) - Set power to ~15", check speed, if < 120 kts, Flaps 10º, slow to 100 kts, GUMPPSS Flow (no propeller change), turn base as needed
    a. Verify 3 green indication, and nose gear down in mirror
12. On base - Check speed, if < 120 kts, Flaps 20º, slow to 90 kts, GUMPPSS flow (no propeller change), turn final as needed
13. On final – Check speed, if < 110 kts, Flaps 35º, maintain 90 kts, GUMPPSS flow (propeller High RPM), touchdown on 1000 ft aiming point marker

GO AROUND

1. Power – full
2. Establish climb attitude
3. Flaps – Up
4. Climb at V_Y (85 Kts / Blue line)
5. Positive rate verified - Gear Up

SHORT FIELD TAKEOFF / LANDING

1. Before entering runway – GUMPPSS Flow
2. When aligned with centerline – Hold Brakes, Increase power 2000 RPM
3. Check engine instruments
4. Release brakes, Advance throttle to full power
5. Rotate at V_R (71 kts)
6. Climb at V_X (71 Kts), or just before stall indication, until > 50 ft AGL
7. Accelerate to V_Y (85 Kts / Blue line)
    a. When positive rate, no usable runway verified – Gear UP
8. Fly normal pattern (see Normal Takeoff / Pattern / Landing 8 – 12)
9. On final – Check speed, if < 110 kts, Flaps 35º, GUMPPSS flow (propeller High RPM), maintain 80 kts, touchdown on 1000 ft aiming point marker or designated touchdown point

SINGLE ENGINE PATTERN / LANDING

1. Upon engine failure – Engine failure flow (See Section 4: Emergency procedures)
2. Climb at V_Y (85 Kts / Blue line)
3. Fly Normal Pattern (see Normal Takeoff / Pattern / Landing)
4. On Final, <u>maximum</u> Flaps 20º
5. **<u>SINGLE ENGINE GO AROUND NOT ADVISED</u>**

INSTRUMENT APPROACH

1. Normal Descent (Power: 19 – 20" / 2300 RPM)
2. Descent checklist
3. Upon reaching IAF (or 8-10 miles from FAF if vectored for ILS), Set power 20"/ 2300 RPM
4. Pre-landing checklist
5. When 1.5 dots before glideslope intercept (or 1.5 miles from FAF for non-precision approach)
    a. Set power to 16"
    b. Check speed, if < 140 kts, Gear down
    a. When speed < 120 kts, Flaps 20º, slow to 100 kts (~16 - 17" / 2300 RPM), GUMPPSS Flow (no propeller change)

   b. Adjust power as needed to maintain altitude and 100 kts
   c. Upon glide slope intercept set power to 15" and begin descent
6. When 1000' AGL, Check speed, if < 110 kts, GUMPPSS flow (propeller High RPM), maintain 90 kts, touchdown on 1000 ft aiming point marker
   a. If circling, maintain Flaps 10º and 100 kts until base, then normal pattern procedures

SINGLE ENGINE INSTRUMENT APPROACH

1. Upon engine failure – Engine failure flow
2. Normal instrument approach procedures
3. When 1.5 dots before glideslope intercept (or 1.5 miles for non-precision approach)
   a. Check speed, if < 140 kts, Gear down
   b. When speed < 120 kts, Flaps 10º, slow to 100 kts, GUMPPSS Flow (no propeller change)
   c. Adjust power as needed to maintain altitude and 100 kts until glide slope intercept
4. When 1000' AGL, Check speed, if < 120 kts, maximum Flaps 20º, GUMPPSS flow (propeller High RPM), maintain 90 kts, touchdown on 1000 ft aiming point marker
   a. If circling, Flaps 0º and 100 kts until abeam touchdown point, then single engine pattern procedures
5. **SINGLE ENGINE GO AROUND / MISSED APPROACH NOT ADVISED**

Section 7:
Oral Review

1. To maintain instrument currency, a pilot must have made six approaches and demonstrated proper holding procedures as well as radial and bearing tracking in the last six months.

2. An alternate is not required if, your destination has an approved instrument approach, and the weather at your destination is forecast to be at least a 2000 foot ceiling and visibility of at least three miles. This forecast mut be from one hour before to one hour after your estimated time of arrival.

3. If an alternate is needed, the weather must be at least a ceiling of 600 feet and visibility of two miles for precision approaches and a ceiling of at least 800 feet and visibility of two miles for non-precision approaches.

4. Reserve fuel of 45 minutes is required for IFR flights; 30 minutes for VFR day flights; and 45 minutes for VFR night flights. The reserve is required in addition to the fuel required to fly to your destination and alternate.

5. If radio communications are lost during IFR flight, squawk 7600. Fly the highest of the MEA, your assigned altitude or your expected altitude.

6. VOR limits: 4 degrees for VOT, ground checkpoint and dual check. 6 degrees for an airborne check.

7. VOR equipment must be checked every 30 days.

8. Transponders must be checked every 24 calendar months.

9. Pitot static systems must be checked every 24 calendar months.

10. ELT equipment must be checked after half of the battery life or after 1 hour of cumulative use.

11. An aircraft used for hire must have a 100 hour and an annual inspection.

12. In order to descend below the DH or MDA, all of the following conditions must be met:
   1. The required flight visibility is met
   2. The aircraft is in a normal position to land
   3. The landing runway must be in sight:
      a. The runway environment is in sight – descend to land
      b. Approach lights in sight – descend to 100’ above touchdown zone elevation until runway environment is in sight
      c. Descend and land if red terminating bars or red side row bars are in sight

13. Multi engine aircraft with V_{SO} of 61 knots or less, or a gross weight under 6000 pounds do not have to demonstrate positive single-engine climb performance per FAR 23

14. The minimum equipment includes a list of equipment that may be inoperative for a particular phase of flight. If not required to have a MEL, comply with the minimum equipment prescribed by the FAR's.

Be prepared to answer the following:

1. What are the V speeds for the Duchess?

2. What is the maximum crosswind component?

3. Describe the engines:
   A. How many cylinders are there on the BE-76?
   B. Who is the manufacturer of the engines?
   C. What is the engine horsepower rating?
   D. Does it have fuel injection or carburetors?
   E. Are the engine normally aspirated or turbocharged?
   F. Why is the right engine labeled LO-360?
   G. How are the cylinders arranged?
   H. How is ignition provided for the engines?
   I. What are the minimum and maximum oil capacities?

4. Describe the propeller system:
   A. Who makes the propellers?
   B. What does oil pressure do to the propeller?
   C. Which lever manipulates oil pressure to the propeller?
   D. What unit regulates oil pressure to the propeller?
   E. What is the function of the nitrogen cylinder?
   F. What purpose does the spring serve?
   G. Define constant speed.
   H. What unit adjusts the propeller to maintain a constant RPM and how does it do it?
   I. Define full feathering.
   J. Will the prop always feather?
   K. What are the centrifugal stop pins?
   L. What is the true purpose of the centrifugal stop pins?

5. What is the correct action for a propeller overspeed?

6. Describe the electrical system.

7. What are the indications of a failed alternator?

8. Will the engines continue to run with the alternator and battery master switches turned off?

9. Describe the vacuum system.

   A. Which instruments are vacuum operated?
   B. What are the normal vacuum operating limits?
   C. How many vacuum pumps does the BE76 have?
   D. What indications would occur in the event of a vacuum pump failure?

10. Describe the stall warning system.

11. Describe the fuel system.

12. Explain how to cross feed fuel.

13. Describe the landing gear system.

   A. How is the landing gear actuated? Describe the pump.
   B. What keeps the gear in the up position?
   C. What keeps the gear in the down position?
   D. If Hydraulic pressure is suddenly lost in flight, what indication, if any, would you have?
   E. In what three situations will the landing gear horn activate?
   F. What unit will not allow the gear to be retracted on the ground?
   G. What is the procedure to extend the gear manually (Emergency Gear Extension)?
   H. What airspeed is of importance during manual gear extension?
   I. Are the brake and the landing gear hydraulics interconnected?
   J. If you lose gear hydraulics, will you still have brakes?
   K. What indicates that the gear is in transit and the hydraulic pump is activated?

14. What type of braking system is used by the Duchess? Where is the brake fluid serviced?

15. What type of flaps does the Duchess have?

   A. What are the flap settings on the Duchess?

16. What are the maximum taxi, takeoff, and landing weights?

17. What is the maximum baggage capacity?

18. Define V_{SSE}.

19. What are the drag factors on light twins?

20. Who determines VMC for a particular aircraft?

21. Define V_{MC}.

22. Why is an aft CG used in determining VMC?

23. What are the factors in determining VMC?

24. Define critical engine and list the factors used to determine it.

25. What causes an aircraft to sideslip with the loss of an engine, and what action is required to correct this?

26. How much climb performance is lost when an engine fails?

27. What aircraft equipment checks are required under FAR part 91?

28. Define absolute and single-engine service ceiling.

29. What documents are required to be on the aircraft?

30. Explain lost communications procedures.

31. Will the propeller feather below 950 RPM? Why or why not?

32. Explain the pitot static system.

    A. Does the BE-76 have an alternate static source? If so, how is it activated and what actions are necessary to acquire the most accurate reading?
    B. What instruments are pitot static?
    C. Where is the pitot static port located?

33. How do you prevent a heater overheat?

34. What is the fuel capacity? How many gallons are unusable?

35. What grade fuel is to be used in the BE76?

36. How many fuel pumps are on the aircraft?

37. When are the electric fuel pumps to be used?

38. What are the various positions on the fuel selector control?

39. Explain the procedure for cross feeding fuel when operating the right engine from the left tank.

40. If an engine failure occurred at 5,000' MSL, or a high density altitude, what would you do to get max performance from the operating engine after performing the In-Flight Engine Failure Checklist?

41. If the cylinder head temp and oil temp approach the caution range, what can be done to assist in cooling?

42. Why does manifold pressure decrease approximately 1" every 1,000' during climb?

43. When an engine is inoperative or feathered, what indication will be observed on the manifold pressure gauge?

44. Why is the manifold pressure gauge not necessarily a good indicator in determining an inoperative engine?

Appendix 1: BE76 Duchess Quick Reference Specifications

N24GM – 1981 Beechcraft BE-76 (Duchess)

Max Takeoff Weight	3900 lbs	*Electrical*	28 volt DC system
Empty Weight	2446 lbs		24volt/33amp battery
Useful Load	1470 lbs		55 amp ALT x2
		Anti-Ice	Carb Heat
Fuel Capacity	103 gallons		Pitot Heat
Useable Fuel	100 gallons (1.5 each tank)		Defrost
	2 tanks, 1 each wing	*Tires*	Nose 38 psi
	Crossfeed avail- level flt, emergency only		Main 38 psi
	Tabs – 40 gallons and 30 gallons		
	100 LL minimum grade		
Oil Capacity	8 qts	*Mag Check*	Max 175 rpm
			Diff of 50 rpm
Engine	Lycoming O-360-A1G6D and LO-360-A1G6D		
	Rated at 180hp @ 2700 RPM		

L – Lycoming, 4 cylinder

H – horizontally opposed

A – air cooled

N – normally aspirated

D – direct drive

Normal Category	3900 lbs	Flaps up +3.8G	-1.52G
		Flaps dn +2.0G	

Aerobatic maneuvers, including spins are PROHIBITED

Max Slip Duration = 30 seconds

N24GM – 1981 Beechcraft BE-76 (Duchess)

Airspeed Limitations

Vne	*Maximum*	194 kts (red line)
Vno	*Caution range*	154 – 194 kts (yellow arc)
	Normal range	70 – 154 kts (green arc)
Vfe	*Flap range*	60 – 110 kts (white arc)
Va	*Maneuvering (3000)*	116 kts
Va	*Maneuvering (3900)*	132 kts

V-Speeds

Vmc	*minimum controllable airspeed* (red radial)	65 kts
Vso	*stall dirty*	60 kts
Vs	*stall clean*	70 kts
Vr	*rotate*	71 kts
Vx	*angle*	71 kts
Vxse	*angle single engine*	85 kts
Vy	*rate*	85 kts
Vyse	*rate single engine* (blue radial)	85 kts
Vlo/up	*gear retraction*	112 kts
Vle/dn	*gear extension/down*	140 kts
Vfe	*flaps extend (full)*	110 kts
Vfe	*flaps extend (20)*	120 kts
Vg	*best glide (3000lb)*	82 kts
Vg	*best glide (Max Gross)*	95 kts
Max Demonstrated Crosswind		25 kts

Appendix 1: COMMERCIAL AMEL ADD-ON SYLLABUS

8.5 Hours

7.0 Hours – Prep
1.5 Hours – Checkride

Daily Schedule

Day One
Ground – Flight – Ground – Flight

Day Two
Flight – Ground – Flight – Ground – Flight

Day Three
Flight/Ground as needed – Checkride

Flight Breakdown

Flight One
1.0 Hours – checklist usage, pattern work, power settings, takeoff & landings

Flight Two
1.5 Hours – steep turns, power-on/off stalls, slow flight, V_{MC} demo, simulated engine outs, instrument approach, takeoff & landings

Flight Three
1.5 Hours – steep turns, power-on/off stalls, slow flight, V_{MC} demo, simulated engine outs, instrument approach, full engine shutdown, takeoff & landings

Flight Four
1.5 Hours - steep turns, power-on/off stalls, slow flight, V_{MC} demo, simulated engine outs, single engine instrument approach, full engine shutdown, takeoff & landings

Flight Five
1.5 Hours – checkride prep – review above items as necessary

Appendix 2: CFI – AIRPLANE MULTIENGINE ADD-ON SYLLABUS

6 Hours

4.5 Hours – Prep
1.5 Hours – Checkride

Daily Schedule

Day One
Ground – Flight – Ground

Day Two
Ground – Flight – Ground – Flight

Day Three
Flight/Ground as needed – Checkride

Flight Breakdown

Flight One
1.3 Hours – checklist usage, pattern work, power settings, simulated engine outs, takeoff & landings

Flight Two
1.5 Hours – steep turns, power-on/off stalls, slow flight, V_{MC} demo, drag demo, full engine shutdowns, takeoff & landings

Flight Three
1.7 Hours – steep turns, power-on/off stalls, slow flight, V_{MC} demo, drag demo, full engine shutdowns, takeoff & landings

Appendix 3: Duchess 24GM Panel Picture