Multi engine systems

PA 34-200 Seneca

Engine

Make : Avco Lycoming

Model:

Right Engine LIO-360 C1E6(turning counter clockwise from the cockpit)

Left Engine IO-360 C1E6

Type:

- 4 cylinders
- Horizontally opposed
- Normally aspirated(No turbo charge)
- Air cooled (Engine oil and fuel helps cooling)
- Direct drive(Propeller is attached to the crank shaft directly without any reduction gear or transmission)
- Fuel injected

Horsepower: 200 BHP

Alternate air: Working as a carburetor heat. Heated air around exhaust manifold is directed through the alternate air source. RPM drops slightly when it is open.

Cowl flap: Manually operated. There are three positions; open, half and closed.

Propeller

Make: Hartzell
Model:
Type: Constant speed, full feathering propeller
What is a constant speed prop?

The propeller which maintains the RPM selected by propeller control lever constant regardless of airplane's pitch attitude or throttle position within some range.

The advantage of a constant speed prop.

The pilot can select the most efficient blade angle for each phases of operation. By selecting low pitch/high RPM, you can get maximum power for takeoff. By selecting high pitch/low RPM, you can fly faster at low RPM and you can save the fuel for cruise.

How does it work?

When the airplane rise it's nose, it start climb. As it climb, airspeed goes down. The RPM is also going

down due to increasing drag on the blade. However, blade angle is decreased automatically to reduce the drag to maintain the RPM constant.

When the airplane drops it's nose, it start to descend. As it descend, airspeed will increase. The RPM is also increased due to decreasing drag on the blade. However, blade angle is increased automatically to increase the drag to maintain the RPM constant.

Where is the governor located?

In front of the engine.

What does governor do?

The fly weight inside the governor senses the change in RPM by sensing the change in centrifugal force. It opens the pilot valve. When the RPM increase, the valve opens the line without the pump. It drains the oil back from propeller hub to increase the blade angle. When the RPM decrease, the valve opens the line with the pump. The pump send the oil to propeller hub to decrease the blade angle.

What makes it high pitch?

Nitrogen charged in the hub and counter weight at the root of the propeller blades.

What makes it low pitch?

High pressure of the oil and aerodynamic force on the prop.

What does pilot do when he move the prop lever in the cockpit? What will happen to governor?

It change the tension of the speeder spring. High tension requires more centrifugal force on the fly weight. It increase the RPM. Low tension requires less centrifugal force on the fly weight. It decrease the RPM.

Where is the oil from?

Engine oil reservoir at the bottom of the engine.

What will happen if you lose engine oil completely?

It become high pitch. Moves toward feathering.

How can you feather manually?

Move the propeller lever all the way down to the feather detent.

What is the purpose of feathering?

To reduce the drag caused by windmilling. To avoid further damage to the engine.

What force makes it feather?

Nitrogen charged in the hub and counter weight at the root of the propeller blades.

How can you unfeather the prop?

Use starter.

How does the unfeatering accumulator work?(if it is equipped)

It has diaphragm inside. Nitrogen is charged in one side. Engine oil is pumped in on the other side from the governor during normal operation. When the propeller lever is moved down to feather position, the valve is closed to keep high oil pressure inside the accumulator(300PSI). When the prop lever is moved to high RPM position, the valve is opened and the nitrogen push the oil back. The oil is sent to the hub through the governor and crankshaft to decrease blade angle. Once the blade angle changes, the wind pick up the prop to start windmill. In this way, the engine can be restarted without stress on the cylinders(N43130 does not have unfeathering accumlator).

Will the prop feather when you shut down the engine after landing? Can you feather the prop when engine is not

running?

No. There is anti-feather lock pin which prevent the prop from feathering below, 800RPM. When the RPM is high, the pin hide inside sleeve due to centrifugal force. When the RPM is low, the spring push out the pin to stop the movement of the prop.

Fuel system

What is the fuel system of the Seneca?

Fuel pump system.

How many fuel pumps are there?

4. Each engine has engine driven fuel pump and electrical fuel pump.

What drives fuel pumps?

Engine driven and electrical motor.

When do you use electrical fuel pump?

To start the engine.

Takeoff, climb and landing.

When the engine driven pump is inoperative.

How many fuel tanks are there?

Two integral tank in each wing. Total four tanks.

What is the capacity of each tanks(total/usable)?

Total 98 gallons. 2.5 gallons unusable each side makes usable fuel of 93 gallons.

How many fuel gauges are there?

Three. Fuel quantity gauges. Fuel pressure gauges. Furl flow gauges.

Can you send the fuel from right tank to left engine? How?

Yes. Select cross feed on the left fuel selector valve. The P.O.H says fuel selector valve for the inoperative engine should be “off”.

When can you use the cross feed line?

Only in cruise.

Can you select cross feed on both engine?

P.O.H said "NO" though you can physically position it.

What is the purpose of cross feed?

To balance the weight laterally when one engine is inoperative. For longer range/endurance.

Draw the fuel system.

Refer P.O.H.

How many drains are there? Where are they located?

Eight. There are two quick drains on the bottom of the fuselarge which is drained by the levers in the cockpit. Each fuel tanks (4). Fuel filter on each engine (2).

What is the minimum grade of fuel?

100.

How can you make sure you have correct fuel?

Color. 100 is green. 100 LL is blue.

Landing gear

Type of the landing gear?

Tri-cycle, retractable.

How does it work?

It is electrical-hydraulic system. Pilot can select the position(up/down) by the gear handle. The electrical motor rotate the hydraulic pump which send the hydraulic fluid from reservoir to three actuators. The fluid move the piston in each actuators to move the push-pull rod which are connected to the landing gears.

Each gear (Left, right main and the nose) has up limit and down limit switches When all three up limit switches are pressed, red unsafe warning light will be off and pump will stop. Also, there is a hydraulic pressure switch. When the gear is up and hydraulic pressure inside reaches certain amount, it disconnect the circuit and the pump will stop. When the hydraulic pressure decrease, pressure switch activate the motor to pump the hydraulic fluid. The pressure switch and the up limit switch is in the serial connection so either pressure reaches the set amount or all three up limit switches are pressed the pump will stop.

When all three down limit switches are pressed, pump will stop and green lights are turned on.

Where is the power pack located?

In the nose baggage compartment.

What is the color of the hydraulic fluid?

Red.

What will happen in the case of loss of hydraulic fluid?

The gear will drop by gravity and spring.

How can you make sure it is down and locked?

Three green lights.

Is there anything to tell you the position of the nose gear?

There is a mirror on the left cowling to check nose gear position

Lock systems(up/down).

Up-No mechanical lock. Only supported by hydraulic pressure.

Down-Over center lock supported by spring and finger hook.

What is the maximum speed you can extend/retract the gear?

Vle is150 MPH. However, for retraction, it must be below 125 MPH.

Is there any system which warns you when you forget to extend the gear for a landing?

There is warning horn. When the throttle is reduced(14”) with gear up, it beeps. When the flap is extended at 25 or 40 degree with gear up, it beeps. It beeps on the ground when the gear handle is up.

And gear unsafe light (red) illuminates if it not fully down or fully up.

What will happen if you move gear handle up while you taxi on the ground?

The warning horn beeps. And gear unsafe light (red) illuminates The gear will not go up because of the squat switch located on the left main gear strut.

What would you do if you don't see green light after you move the gear handle down?

Check master switch on, circuit breaker in, push the light bulb for test, switch the light bulb, turn the navigation light off(navigation light dims green lights). Check if you hear warning horn or not. Check unsafe light.

Explain the manual extension procedure.

Use check list.

Slow down to 100 MPH.

Landing gear lever-down.

Pull emergency gear extension knob.

Check three green lights.

Leave emergency gear extension knob pulled.

What makes gear down when you use manual extension system?

It release the hydraulic pressure. The gravity and the spring pulls gear down.

Electrical system

What is the primary source of electricity?

Alternator

How many alternators are there?

Two

What drives the alternator?

Engine

What is the voltage and capacity of the alternator?

14 volt, 60 Am

How can it maintain the voltage constant while the engine RPM changes from phase to phase?

Voltage regulator maintain it at 14 volt regardless of RPM.

How many voltage regulators are there?

Two. Each alternator has its own voltage regulator.

What is happening if you see over voltage warning light?

Over voltage relay shut down the alternator field as a result of over voltage caused by spike or voltage regulator failure. Recycle the master switch and/or alternator.

How can you make sure one of the alternators is working or not?

Turn off the alternator one at a time. If the other load increase, the alternator you turned off was working.

What is bus bar? Location?

Bus bar is a piece of metal used for the distribution of the electricity. It simplify the wiring. It is located behind the circuit breakers.

How can you detect the alternator failure? What would you do then?

One or both load meters indicate zero. If only one indicates zero, turn off the other one to make sure it is working. If both indicate zero, check master switch on, circuit breaker, recycle alternator. If it still indicate zero, turn off the master switch to conserve the battery. Also alternator warning light on.

How many batteries are there? Location?

One battery in the nose.

What is the voltage and capacity of the battery?

12 volt, 35 amh.

How long does the battery last after losing alternator?

Depend on the load. If you use 35 am continuously, it last 1 hour. If you use 70 am continuously, it last 1/2 hour.

Flight control system

Conventional cable and pulley system. The aileron and the elevator are interconnected. Using rudder cause the aileron to be moved.

Flap

Type of flap: Single slotted
How does it work?

Flap is actuated manually by human power.

Maximum deflection: 40 degrees
Vfe: 125 MPH. However, 160 MPH for the first notch(10 degrees), 140 MPH for the second notch.

Vacuum system

Purpose

To operate the gyro instruments. AI and HI.

Source of vacuum

Two engine driven vacuum pumps.

Normal indication

5 in-hg±0.2

How to detect the failure

There are red flags on the vacuum gauge.

Stall warning system

Electrical warning horn activated with tabs. There are two tabs on the left wing. The out board is activated for flap zero and 10 degrees. Inboard one is for 25 and 40 degrees.

Also stall warning light illuminates.

Heater

Conventional heater same as the one used in Cessna 172.

Ice protection: Pitot heat, carb heat

Hydraulic system: Prop, Brakes, Landing gear

Draw the airspeed indicator.

V speed:MPH

Va: 145

Vx: 90

Vy: 105

Vxse: 93

Vyse: 105

Vsse:

Vmc: 80

Vs0: 69

Vs1: 76

Vno:190

Vne: 217

Vfe:125

Vle: 150

Vr: 85

Before Maneuver Check

1. Seat belt-Fasten.
2. Fuel selector valve-On
3. Mixture-Rich.
4. Fuel pump-On
5. Master switch-On
6. Primer-Lock

Clearing turn

Complete 90 degrees turn to the left, and 90 degrees turn to the right. Depend on the airspace and terrain, right turn may be the first. Watch the blind spot on the left, right, behind and below. Bank should be 15 to 20 degrees.

Slow Flight

Entry

1. Throttle-15 in, maintain altitude.

   As you reduce power, you should anticipate pitch down. Don't watch manifold pressure gauge needle to move from cruise to 15 in. Look at the horizon and cowling as you use peripheral vision. Adjust control pressure to avoid nose from dropping and adjust rudder to keep the heading constant.

2. Airspeed 150 MPH, Landing gear-Down
3. Airspeed 160 MPH-Flap 10
   140 MPH-Flap 25
   125 MPH-Flap 40

   The extension of flap cause nose to move up. If you allow it, you will lose altitude. Anticipate this and you need to add slight forward pressure on the control wheel to avoid this. Watch horizon and cowling. Don't fix your eyes on the airspeed indicator and the flap switch. After you set full flap, you need to apply back pressure to keep the altitude constant.

4. Airspeed 105 MPH (blue line)-Prop to high RPM
5. Airspeed 85 MPH-Throttle, 17 in-18 in, maintatin 80 MPH

   PTS require you to maintain minimum controllable airspeed which is almost 69 MPH for Seneca .However, you need to be able to fly at any speed. Use trim. After this point, generally, pitch controls airspeed and power controls altitude. Remember the pitch attitude which gives you 80 MPH.

Climb

Apply extra power. Adjust pitch to maintain the airspeed. For level off, reduce power necessary to maintain the altitude. Adjust pitch to maintain the airspeed.

Descent

Reduce power as necessary. Adjust pitch to maintain the airspeed. For level off, add power necessary to maintain the altitude. Adjust pitch to maintain the airspeed.

Turn

Use 10 degrees bank. Try to maintain pitch attitude and adjust it to maintain 80 MPH.

Recovery

1. Throttle-Full, maintain the altitude.

   Adjust pitch "gradually" to maintain the altitude. Don't push nose down quickly. Pitch should be changed slowly from slow flight attitude(high) to cruise attitude(level). Look at the horizon and cowling as you scan the altimeter.

2. Flap-25
3. Airspeed 90 MPH-Landing gear-up, Flap 10
4. Airspeed 100 MPH-Flap Up

   The flap retraction cause the nose to move down. You need to anticipate and add back pressure as necessary to maintain the altitude. As airspeed increases, you don't need much right rudder anymore. Airspeed

5. 110 MPH-Throttle Cruise. Prop and mixture set back to cruise. Return to cruise flight. Use trim.

Power Off Stall

Entry

1. Throttle-15 in

   Maintain altitude
2. Airspeed Below 150 MPH-Landing gear-down
3. Airspeed 160 MPH-Flap 10
   140 MPH-Flap 25
   125 MPH-Flap 40
4. Airspeed 105 MPH (blue line)-Prop to high RPM

   1 through 4 are same as slow flight.
5. Start descend at 95 MPH
6. Throttle-12 in. Increase back pressure to keep altitude to reach stall.

   If you do this too aggressive, it will stall deeply. Try to maintain altitude and it will stall gently. You will hear stall warning horn and then feel the buffet.

Recovery

1. Release back pressure.

   You don't need to push nose down too steep.
2. Throttle-Full, Maintain level flight attitude.

   Don't look inside the cockpit. Your right hand is already on the throttle. Just move it forward. Look horizon and cowling. Adjust control pressure to establish level flight attitude.
3. Flap-25

   After retract the flap to 25, return your right hand on the throttle. Wait for the airspeed to increase as you maintain level flight attitude.
4. Airspeed 90 MPH (Vx), Climb attitude

   Look at horizon and the cowling to establish normal climb attitude. And wait.
5. Positive climb-Landing gear-Up, Flap 10

   Avoid pitch change caused by flap retraction.
6. Airspeed 105 MPH (Vy)-Flap Up
7. Level off, Airspeed 110 MPH-Throttle, Prop, Mixture-Cruise.

Power On Stall

Entry

1. Throttle-15 in

   Maintain altitude

2. Airspeed Below 150 MPH, Landing gear-Down
3. Airspeed 105 MPH (blue line), Prop-High RPM
4. Airspeed 90 MPH(Vx)-Throttle 22 in, Climb attitude (slightly higher than normal climb attitude)

   No need to pull nose up very high. If the nose is too high, it will drop a lot and lose excessive altitude after stall. To avoid this, maintain the pitch slightly higher than normal climb attitude at which airspeed is decreasing gradually(about 15 degrees up). Add back pressure to keep this pitch attitude constant as airspeed decrease. Look at the horizon on the both side of the cowling to judge your attitude.

Recovery

1. Release back pressure, Full power
2. Maintain level flight attitude.

   Release back pressure gently to return to the level pitch. Wait for the airspeed to increase.

3. Airspeed 90 MPH(Vx), Climb attitude
4. Positive climb, Landing gear-Up
5. Airspeed 105 MPH(Vy)-Stabilize clime, then level off.

   Since the power on stall is the simulation of the departure stall, the altitude you begin this maneuver is the airport elevation. During recovery, you shouldn't go below the original altitude. If you do so, that mean you crash on the ground. You should finish this maneuver at higher altitude than you begin.

6. Airspeed 110 MPH-Throttle, Prop, Mixture- Cruise.

Accelerated stall (Commercial pilot)

At least 3000 AGL for both SE and ME

1. Throttle 15 in-hg, maintain altitude
2. 105 MPH, Prop-High RPM
3. 45 degrees bank coordinated turn
4. Increase back pressure to reach stall
5. Stall indication, release back pressure, increase power, bank zero, return to level flight

Steep Turn

1. Set up
   - Thottle-20”
   - Prp-2500RPM
   - AS-140 MPH
2. Enter turn with aileron and rudder.
3. When the bank>30
   - Apply back pressure to keep ALT,
   - Add power to keep AS
4. When the bank=45(Private)/50(Commercial), counter aileron to keep bank constant
5. 20 degree before target heading,
   - Start roll out with aileron and rudder
   - Release back pressure
   - Return to level flight attitude
   - Thottle-20”
6. For Commercial, reverse the course to the other direction immediately.

Vmc Demo

Entry

1. Throttle 15”, Maintain altitude.
2. Airspeed 120 MPH
   - Prop-High RPM
   - Left engine-Idle, Maintain heading.
   - Right engine-Full, Maintain heading.
   - Adjust rudder to keep heading constant during power change.
3. Nose up 1 MPH/sec, Maintain heading with rudder.

----------Loss of directional control or any stall indication-----

Recovery

4. Right engine-Close

   Don’t decrease rudder pressure too soon. It will cause the nose to yaw to the left.

5. Nose- Descend attitude
6. Airspeed>90 MPH Right engine, Full

   Add right rudder pressure as you increase power on the right engine to keep heading constant.

7. Maintain 105 MPH(Blue line)

Emergency Descent

Entry

1. Throttle- Idle, begin descent
2. Airspeed <150, Gear down
3. Prop High RPM
4. Maintain 140 MPH with bank as needed.

Recovery

5. Target altitude+200ft, Nose- Level pitch
6. Airspeed<125, Gear up
7. Power- Cruise

Normal Takeoff

1. Flap-0 degrees
2. Taxi into the runway and stop.
3. Set brake. Power 2000 RPM. Check engine gauges.

   Pump brake a couple of time before apply full power to prevent the airplane from moving.
4. Release brake. Apply full power.
5. 85 MPH, rotate. Set pitch up for Vy.
6. No runway available for landing-Landing gear-Up,

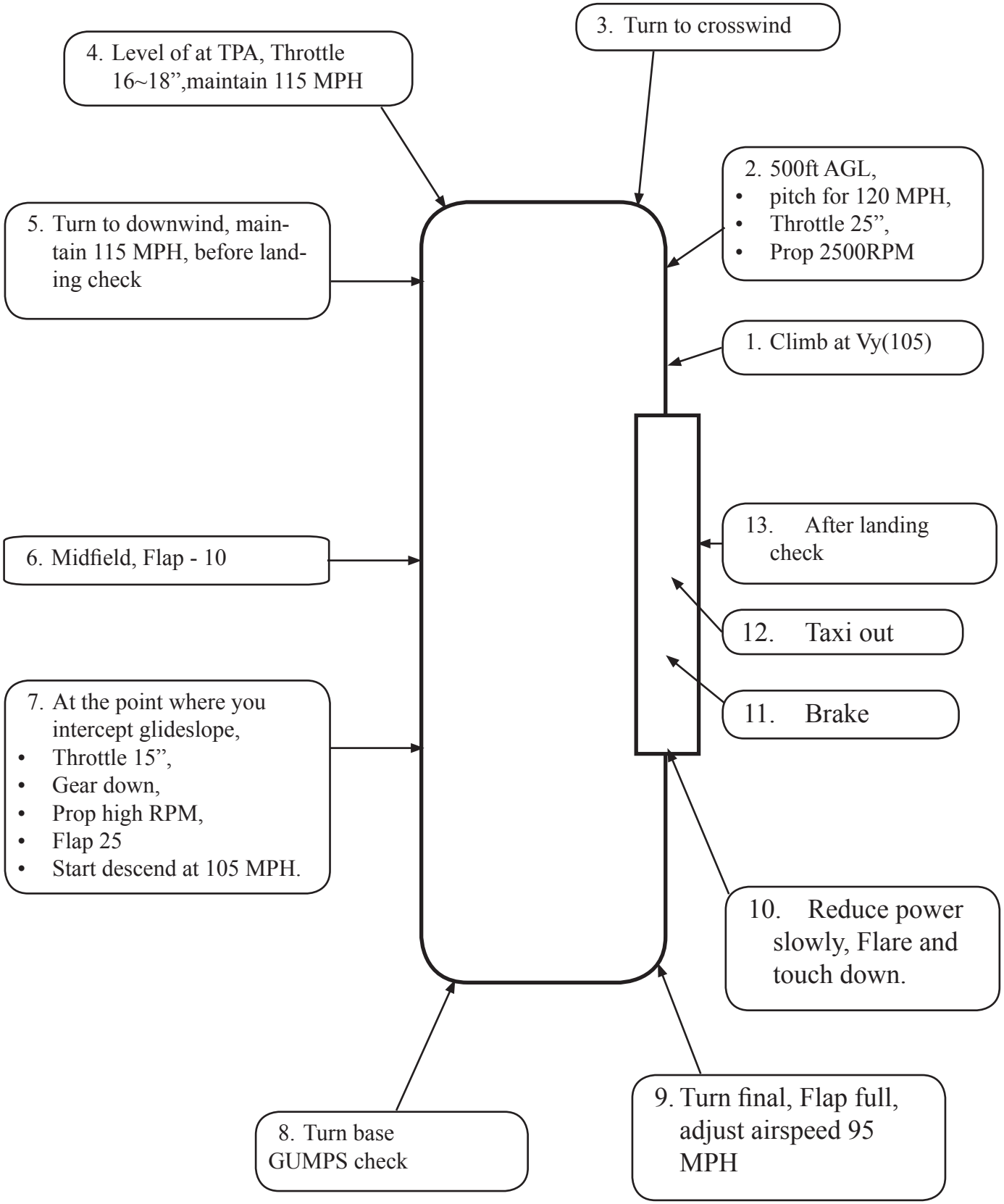
   Check “positive rate of climb” before retract.
7. Climb at 105 MPH(Vy).
8. 500 AGL, Pitch for 120 MPH, throttle-25”, Prop-2,500RPM

Traffic Pattern Operation

1. Climb at Vy(105)
2. 500ft AGL,
   - Pitch for 120 MPH,
   - Throttle 25”,
   - Prop 2500RPM
3. Turn to crosswind
4. Level of at TPA, Throttle 16~18”,maintain 115 MPH
5. Turn to downwind, maintain 115 MPH, before landing check
6. Midfield, Flap -10
7. At the point where you intercept glideslope,
   - Throttle 15”,
   - Gear down,
   - Prop high RPM,
   - Flap 25,
   - Start descend at 105 MPH.
8. Turn base
   - GUMPS check
9. Turn final, Flap full, adjust airspeed 95 MPH
10. Reduce power slowly, Flare and touch down.
11. Brake
12. Taxi out
13. After landing check

GUMPS CHECK

Gas-Fuel selecotor -On
Undercarriage-Three greens
Mixture-Rich
Prop-High RPM
Seat belt, Switch(fuel pump)-On



Short Field Takeoff

1. Set 25 degrees flap.
2. Taxi to the very beginning of the runway.

   Depend on the traffic situation, you don't need to taxi all the way to the beginning of the runway. You can taxi into position as normal takeoff.
3. Set brake. Full power. Check engine gauges.

   Pump brake a couple of time before apply full power to prevent the airplane from moving.
4. Release brake.
5. Slightly before rotation speed, rotate. Lift off at 70 MPH. Set pitch up for 80 MPH at 50 ft AGL.

   Try not to chase the airspeed indicator needle. Remember, airspeed indicator has lag. If you chase, airspeed may be too slow or too fast.
6. At 50ft AGL, lower the nose slightly.

   Again, don't chase the needle of airspeed indicator. Look at the pitch attitude. Make small change in the pitch. You still want to climb. Don't descend.
7. Landing gear-Up, Flap-10 degrees.

   Check "positive rate of climb" before retract. Once you retract the flap, pitch will change. Be prepare for that.
8. Climb at 105 MPH(Vy), Flap-Up, Resume normal climb.
9. 500 AGL, Pitch for 120 MPH, throttle-25", Prop-2,500RPM

Short Field Landing

1. Approach as normal. Full flap on final.
2. Select the top of the first centerline as the touch down point.

   You need to touch down +200/-0ft from that point(private), +100/-0ft (commercial). In this way, you can keep the runway number as the aiming point same as for normal landing.
3. Maintain proper approach speed 87 MPH at least last 1/4 mile on final.

   You don't need to make steep or shallow approach. Just maintain normal approach path all the way to the runway number.
4. Clear the brake

   Make sure that your toes don't touch the brake. Your toe must be on the lower part of the pedal to avoid locking the tire.
5. Reduce power, flare touchdown.

   Do as you do for normal landing. If your approach was correct, it will touch down the point. If your approach was wrong, there is no way to correct at this point. Do no try to touch down on the point by lowering the nose or by releasing back pressure. You will land flat and damage the airplane. If you think you will over shoot, commence go around and make the better approach next time.
6. After touch down, as you maintain directional control, use NOMAL BRAKE.

   In real short field situation, you may need to retract the flap and use full brake. However, during training, we want to avid gear up on the runway and locking the brake, making flat spot on the tires caused by improper use of " full brake". You call out "Flap up, full brake" and use normal brake instead of full. Leave the flap down.

Emergency (One engine failure)

Indication Yaw & Roll. Uncontrolled yaw and roll occur and nose goes down.

During takeoff roll<Rotation speed-Close both throttle, maintain directional control, brake

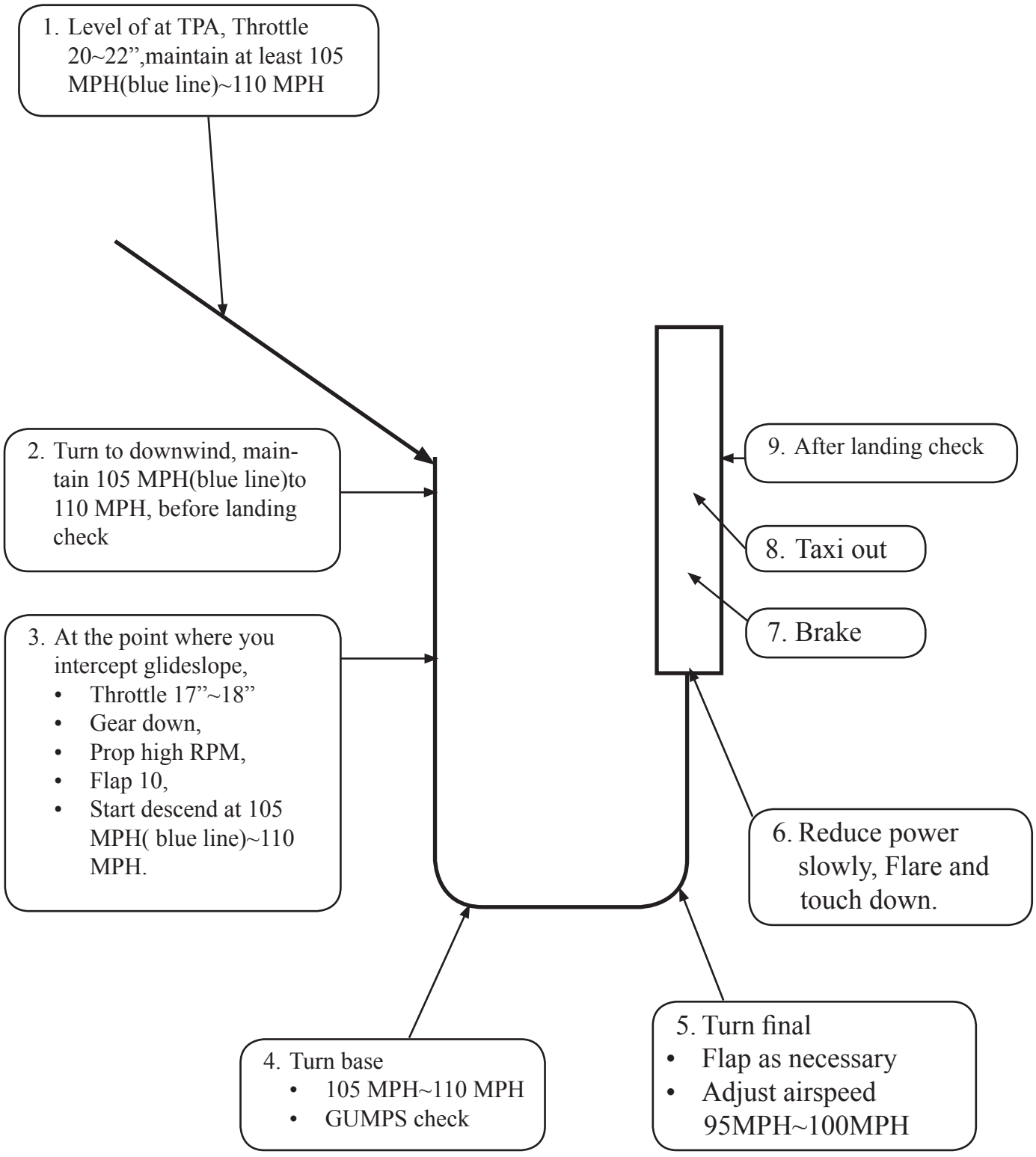
In flight

1. Control
   - Directional control-rudder
   - Airspeed-Blue line(105)
2. Power
   - Mixture- Rich
   - Prop- High RPM
   - Throttle- Open
3. Drag
   - Flap-Up
   - Gear-Up
4. Identify dead engine "Dead foot, dead engine"
5. Verify dead engine Dead engine throttle-Close
6. Check altitude
   - Lower than 2000AGL-Feather dead engine
   - Higher than 2000AGL- Trouble shoot with check list,If still dead-Feather dead engine
7. Secure dead engine with check list
8. Make a decision
   - Continue to the destination?
   - Divert to the nearest airport?

Single Engine Landing

After losing one engine, follow engine out procedure and feather dead engine. Enter traffic pattern. Maintain at least 105 MPH(blue line) until rolling out on final.

1. Level of at TPA, Throttle 20~22",maintain at least 105 MPH(blue line)~110 MPH
2. Turn to downwind, maintain 105 MPH(blue line)to 110 MPH, before landing check
3. At the point where you intercept glideslope,
   - Throttle 17",
   - Gear down,
   - Prop high RPM,
   - Flap 10,
   - Start descend at 105 MPH(blu line)~110 MPH.
4. Turn base
   - 105 MPH~110 MPH
   - GUMPS check
5. Turn final
   - Flap as necessary
   - Adjust airspeed 95 MPH~100 MPH
6. Reduce power slowly, Flare and touch down.
7. Brake
8. Taxi out
9. After landing check



Instrument Approach Procedure

1. ATIS (When you are close to destination)
2. Descend check list
   - Heading indicator-set
   - Altimeter-set
   - Cowl flap-as required
   - Fuel selector valve-On
3. Complete approach briefing
4. Set approach configuration (on initial approach segment or vectored for downwind)
   - Throttle-15”
   - Prop-2500 RPM.
   - AS<160, Flap-10
   - Throttle-16” to 17” enough to maintain 115 MPH.
5. Before landing check (except gear and prop)
6. Step down
   - Throttle-12”
   - Nose-lower for descend
7. Level off
   - Nose-level
   - Throttle-16” to 17” enough to maintain 115 MPH.
8. FAF(intercepting GS for ILS)
   - Gear-down
   - Prop-high RPM
   - Flap-25
   - Start descend (500FPM for ILS)
   - 5 Ts (turn, time, twist, throttle, talk)
9. GUMPS check
10. At MDA-level off, Throttle-20” to 22”.
    - When you see the runway-full flap, slow down to 95 MPH, flare and touchdown.
    - If you reach missed approach point with no visual clue, commence missed approach.
11. Missed approach
    - Throttle-full
    - Positive climb-gear up, flap up
    - Climb at Vy(105)
    - Open cowl flap
    - Comply missed approach instruction or as published
    - Complete after takeoff check list