Commercial Pilot
Airplane Multiengine Land Course

Welcome to your Commercial Pilot, Airplane Multiengine Land Rating course. Whether you are adding your multi-engine rating to an existing certificate or working toward your initial commercial rating you should find this study guide helpful in your preparation for the multiengine checkride. The Diamond DA42 L360 "Twin Diamond." is fully IFR, equipped with integrated G1000 avionics, dual comm/navs, transponder, and ADS-B Out/In.

This course requires reading and self-study. As a commercial pilot, you must have an in-depth knowledge of the aircraft you fly and its systems. This course is designed to build upon the knowledge you gained during your Private Pilot, instrument and commercial single engine training. You must also learn about aircraft systems that are not on our airplanes but on which the Commercial ACS requires you to have basic knowledge and on which you will be tested. Therefore, you will need a working knowledge of and be able to explain them in detail. Wherever the word 'explain' is used in this document or in the Commercial Pilot ACS, the connotation means 'teach.'

Throughout, you must think as a commercial pilot. You are expected to act as Pilot-in-Command. This includes, but is not limited to, getting weather and NOTAMS, computing takeoff and landing data, being familiar with and in later flights, briefing the flight and the maneuvers. You will be expected to make a go/no-go decision based on weather or other factors.

Training flights will be conducted when IFR conditions exist, if flight to VMC conditions can be done (VFR-on-top) and the intended training can be accomplished or an instrument flight with several approaches can be done.

You are responsible for your actions and progression in this course. The more self-study and preparation you do, the better the in-flight practice will be and the lower the cost to you. You will self-evaluate your performance after each flight, pointing out both the good and bad points. However, the instructor has the final decision on your performance.

The following information comes from the Diamond DA42 L360 AFM.

Memorization Items for Diamond DA42 L360 "Twin Diamond"
Engines 1. Left Engine - Lycoming IO-360-M1A (Normal clockwise rotation) 2. Right Engine - Lycoming LIO-360-M1A (Counterclockwise rotation) 3. Max Power (Takeoff Power): Full Throttle, RPM 2700 generating 180 horsepower at sea level. All Engines Operating Limited to **5 minutes**, OEI **No Limit** 4. Max Continuous Power: Throttle 26.7", RPM 2700 generating 160 horsepower at sea level
Propellers 1. 3 bladed MT propellers (LH/RH) 2. Diameter 72.05"
Fuel & Oil 1. 100 LL Aviation Gasoline 2. Usable Fuel – Main Tanks 2 x 25 gal/ Aux Tanks 2 x 13.2 gal 3. Maximum permissible difference LH/RH **5 gallons**. 4. Oil – Aeroshell ASE 50 8 qts. (max); 4 qts. (min VFR) 6 qts. (min IFR)

Weights

1. Max. Takeoff – 3935 lbs.
2. Max. landing – 3748 lbs.
3. Zero Fuel Weight – 3638 lbs.
4. Min. Flight Weight -3009 lbs
5. Max. Wt. Nose Baggage – 66 lbs. – 2 Ballast Weights are Installed (11.2 lbs each)
6. Max. Wt. Baggage Behind Rear Seats – 100 lbs.

Airspeed Limitations & definitions of each

1. V_{NE} – 194 KIAS
2. V_{NO} – 155 KIAS
3. V_{LE} – 194 KIAS
4. V_{LOE} – 194 KIAS
5. V_{LOR} – 156 KIAS
6. V_A > 3400 lbs. – 126 KIAS
7. V_A < 3400 lbs. – 120 KIAS
8. $V_{FO/FE}$ APP– 137 KIAS
9. $V_{FO/FE}$ LDG– 111 KIAS
10. V_{REF} – 85 KIAS
11. V_{SSE} – 80 KIAS
12. V_{YSE} – 90 KIAS
13. V_Y – 90 KIAS
14. V_{XSE} – 85 KIAS
15. V_X – 85 KIAS
16. V_R – 78 KIAS
17. V_{MC} – 65 KIAS
18. V_S – 64 KIAS
19. V_{SO} – 57 KIAS

Aircraft Dimensions

1. Wingspan – 44.03 ft.
2. Height – 8.17 ft
3. Length – 28.08 ft.
4. Wing Area – 175.3 $ft.^2$

Tricycle Landing Gear

1. Tire size nose – 5.00 X 5.0 (10 ply rating)
2. Tire size mains – 15.00 X 6.0 (6 ply rating)
3. Tire pressure nose – 87 psi
4. Tire pressure mains – 65 psi

Required Commercial Pilot MEL Knowledge Items:

The information & schematics below are extracted directly from the DA42 L360 AFM

Landing gear system schematic – You must be able to:

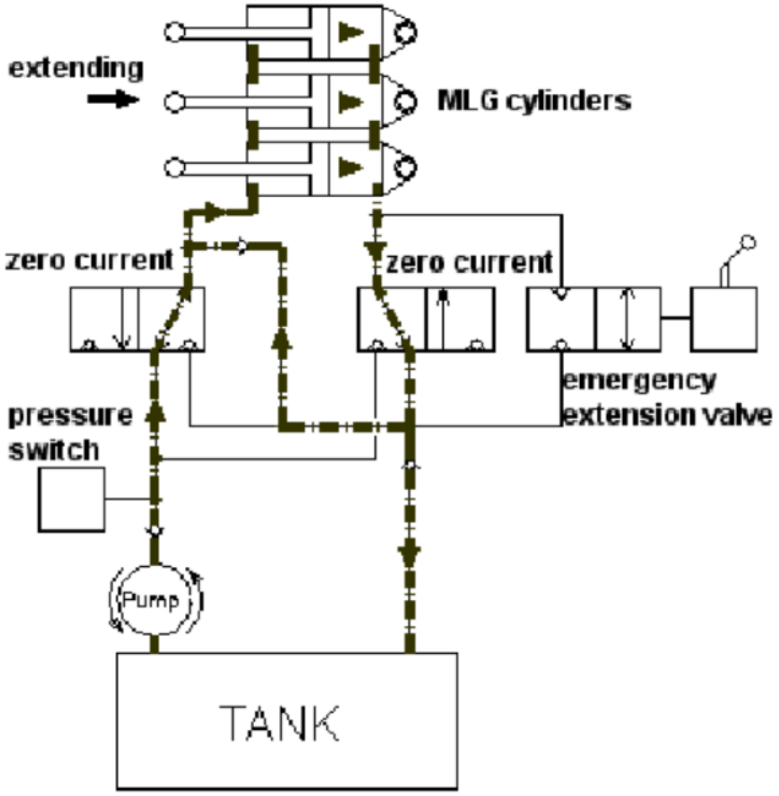
1. Explain how the system works.
2. Explain how the system can fail.
3. Explain how the emergency checklist will help solve any problems.
4. Explain the Landing Gear Electrical Schematic and how it relates to the Hydraulic system.

DA42 L360 Landing Gear System

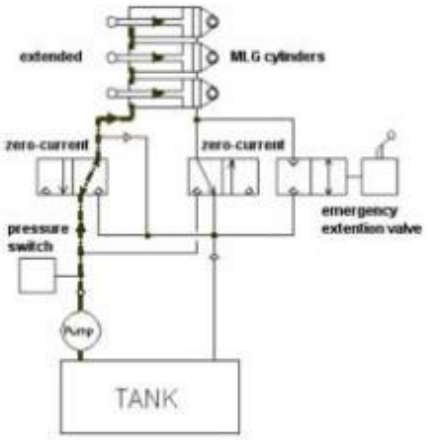
Hydraulic gear extension system schematic:

The main landing gear of the DA42 L360 is extended with three hydraulic cylinders. The following schematic figures show the system conditions for each operating mode.

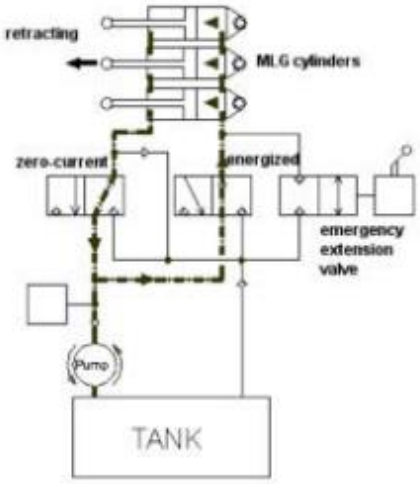
In the figure below, the extension of the landing gear is shown. To reduce the amount of pumped hydraulic fluid during this operation, the return flow is partly led into the feeding flow of the system.



The figure below shows the system status when the landing gear is extended. All hydraulic cylinders are under high pressure.

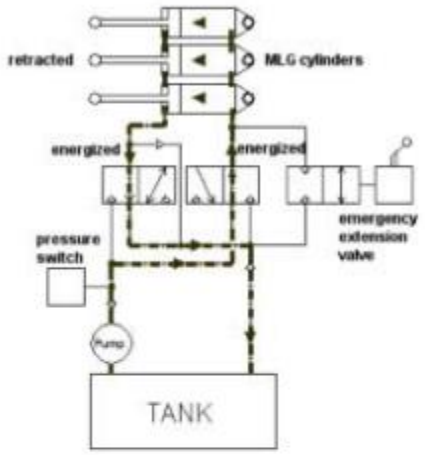


The operating mode for the retraction of the landing gear is shown in the next figure. While energizing the right pressure switch, the fluid flow in the hydraulic system is started due to different piston areas of the landing gear cylinders although the pressure on both sides of the system is equal.

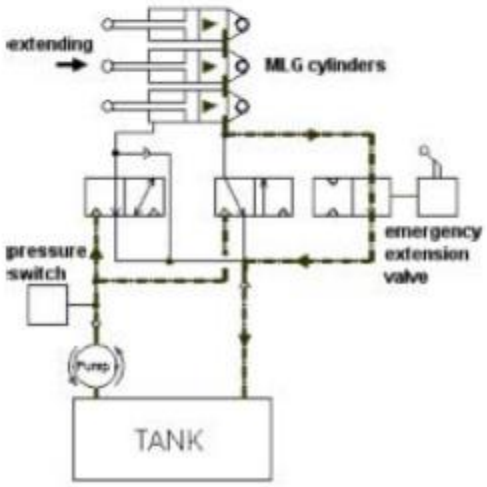


Gear Retracted

While the landing gear is retracted both valves are energized and excessive hydraulic fluid on one side is drained into the tank. This configuration of the system is shown in the following figure.



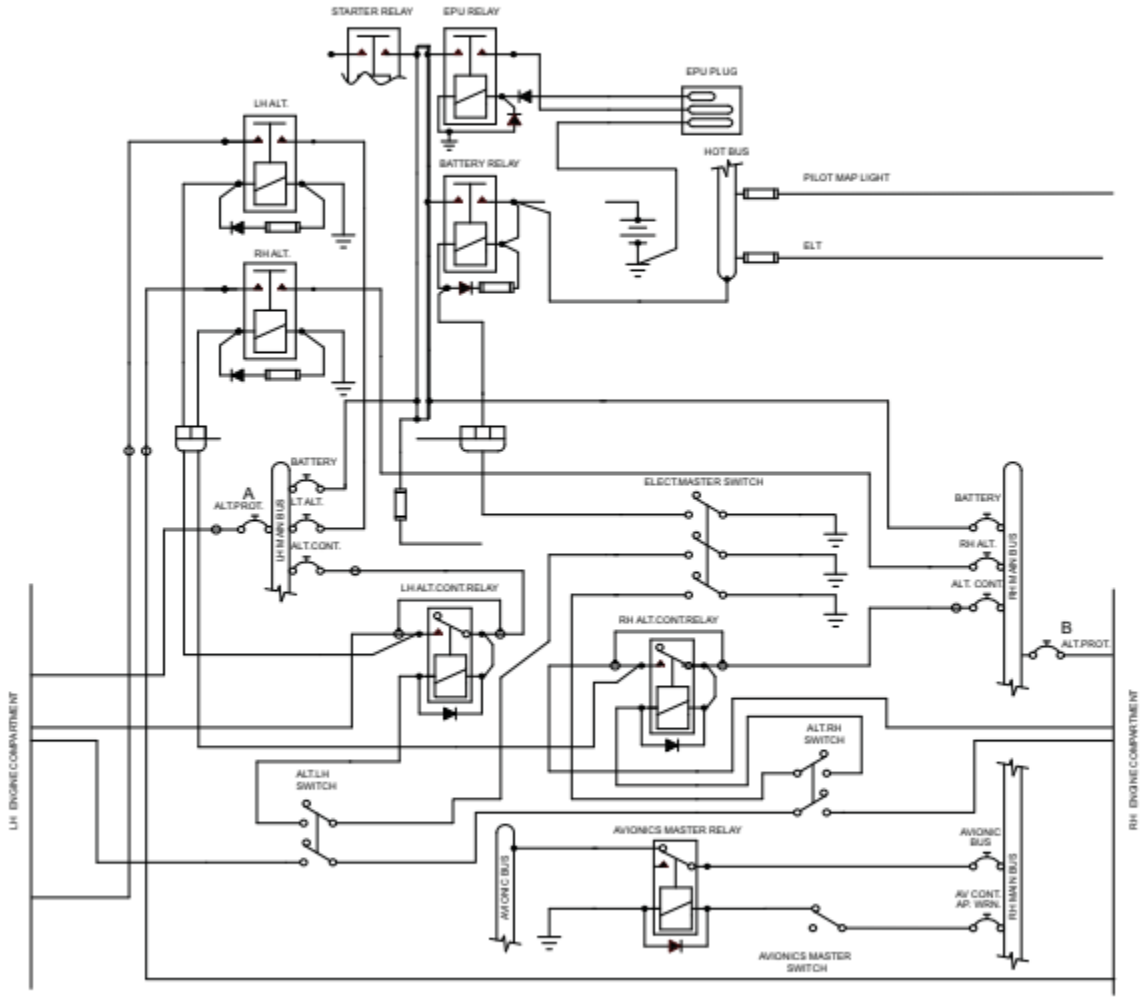
For an emergency extension of the landing gear, the hydraulic fluid can pass through an emergency extension valve so that the gear is extended by gravity. The condition of the system is shown in the figure below.



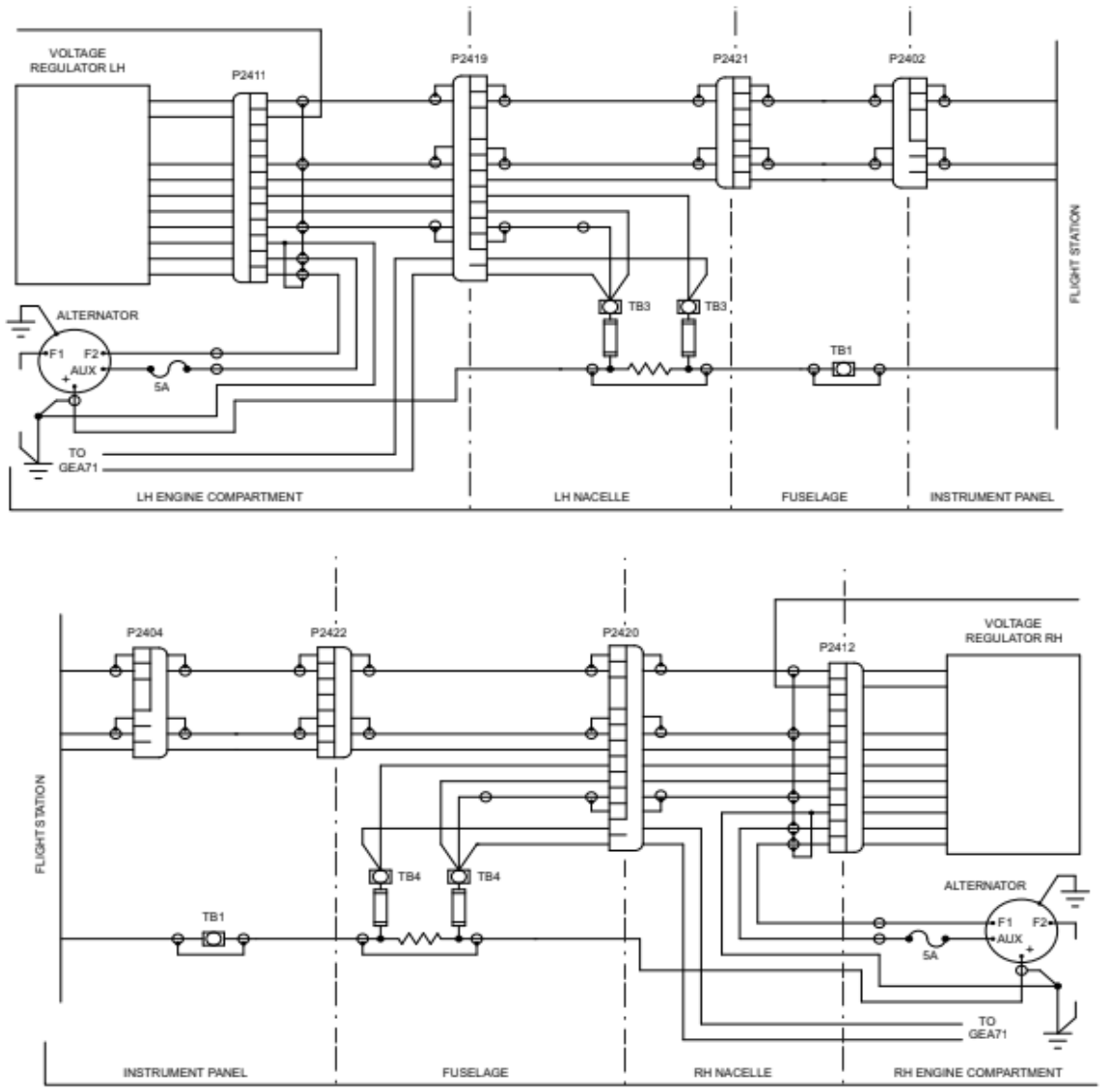
Electrical System – You must be able to:

1. Explain the Electrical schematic.
2. Explain how the system can fail.
3. Explain alternator power output, battery storage capacity, and emergency backup battery.
4. Explain how the emergency checklist can help solve any problems.

Electrical System Schematic (Sheet 1 of 2)



Electrical System Schematic (Sheet 2 of 2)



LH (Top) and RH (Bottom) ENGINE COMPARTMENT AND STUB WING

Fuel System

1. Explain the Fuel System in the DA-42
2. Explain how it works to include fuel system control
3. Explain how fuel from the Aux tanks can be used
4. Explain how the system can fail
5. Explain how the emergency checklist may restore the system to functionality

7.10.5 FUEL SYSTEM

General:

Fuel is stored in the main tanks located in the wings and the auxiliary tanks in the nacelles. Normally fuel for the right engine is taken from the right wing tank / right auxiliary tank and for the left engine from the left wing tank / left auxiliary tank.
Both sides of the fuel system are interconnected by cross feed lines.

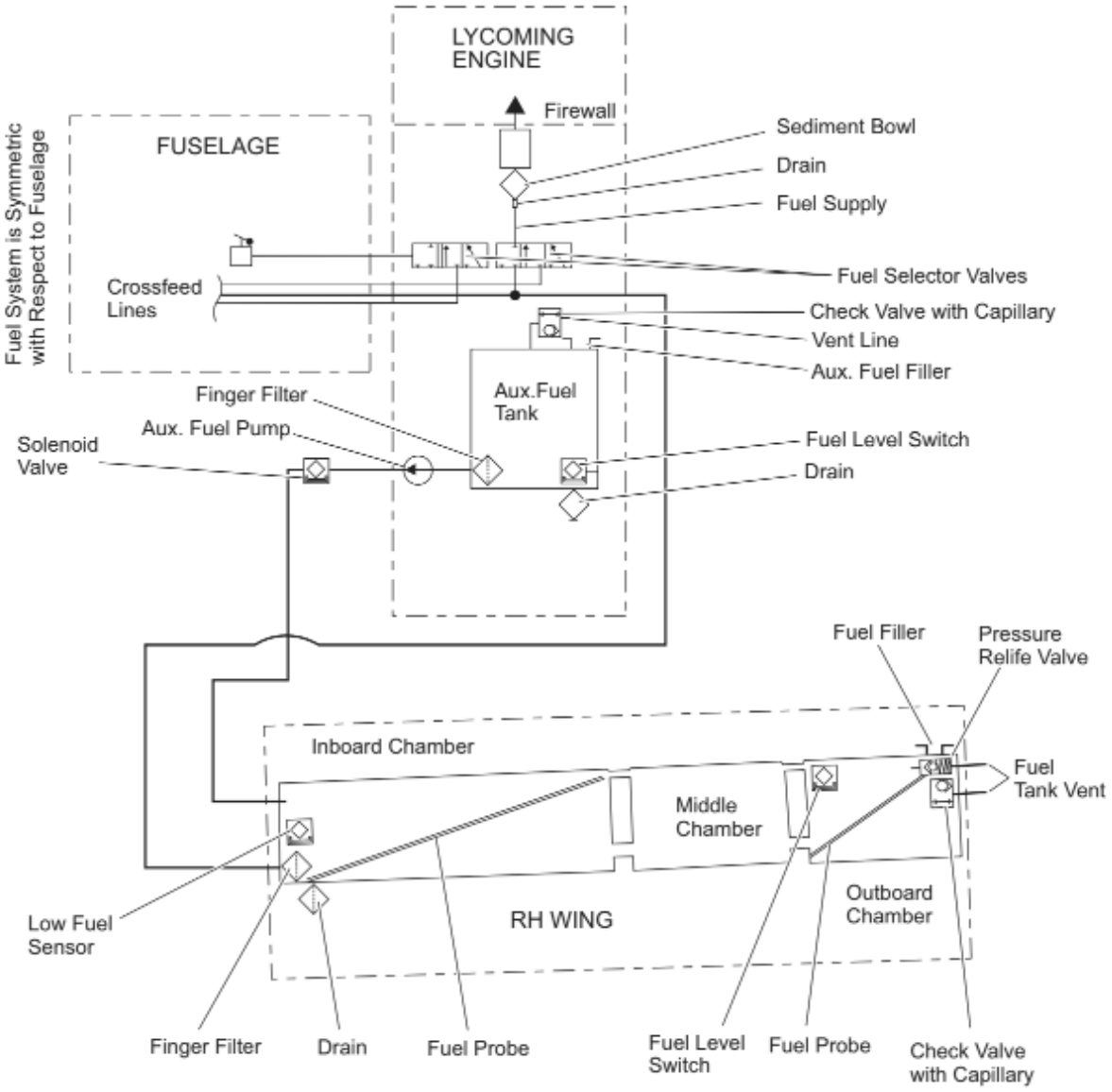


Figure 1:

Normal Operation

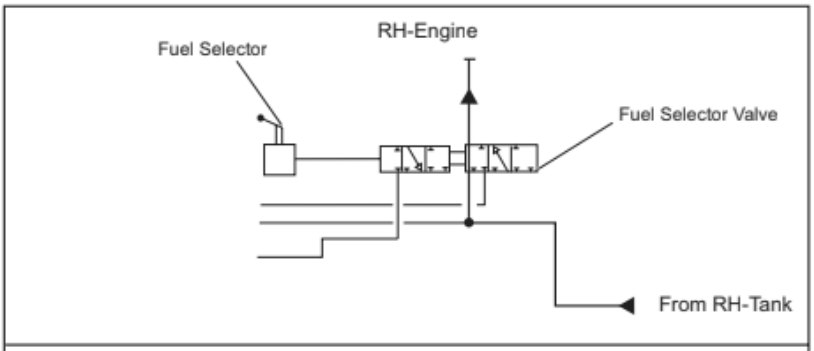


Figure 2:

Cross-feed Operation

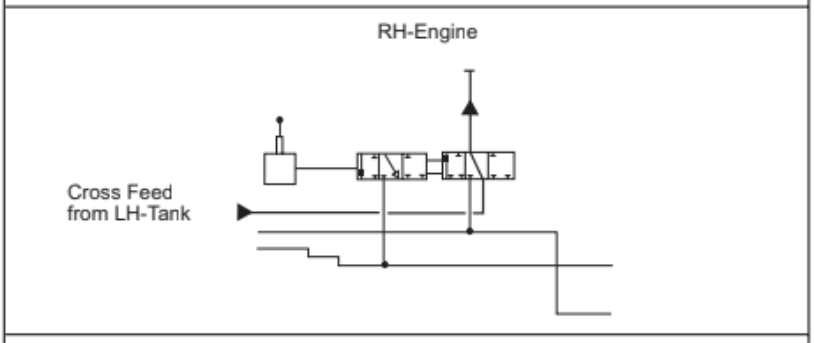
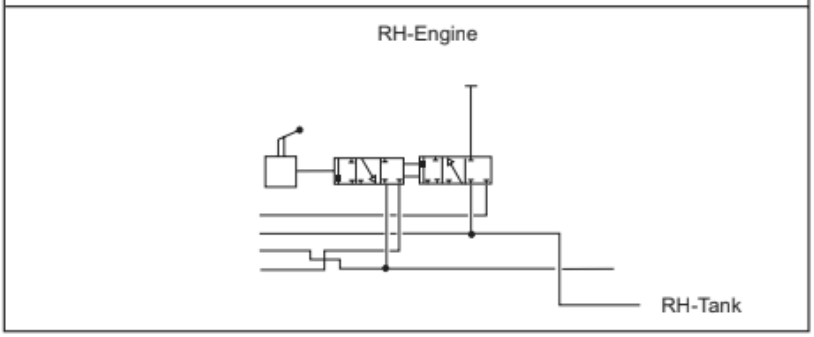


Figure 3:

Shut-off Position



Fuel selector valves:

For each engine one fuel selector valve is provided. The control levers for the fuel selector valves are situated on the center console behind the engine controls. The positions are ON, CROSS FEED and OFF. During normal operation each engine takes the fuel from the tank on the same side as the engine. When CROSS FEED is selected, the engine will draw fuel from the tank on the opposite side in order to extend range and keep fuel weight balanced during single engine operation.

The desired position is reached by pulling the lever back. To reach the OFF position a safety guard must be twisted. This is to ensure that this selection is not made unintentionally.

Scheme of the fuel selector valve positions:

Possible operating modes for the three fuel selector valves are depicted in the following illustrations. The figures that follow show fuel flows for the RH engine (fuel flows for the LH engine are the same):

With the LH fuel selector valve in cross-feed position, the fuel from the RH tank is transferred to the LH engine. Depending on the position of the RH fuel selector valve, the RH tank then feeds both engines (as shown in figure 4 below) or only the LH engine, when the fuel selector valve of the RH engine is in shut-off position (as shown in figure 5 below).

Figure 4:

Fuel Selector Valve RH normal operation, LH valve in cross-feed position

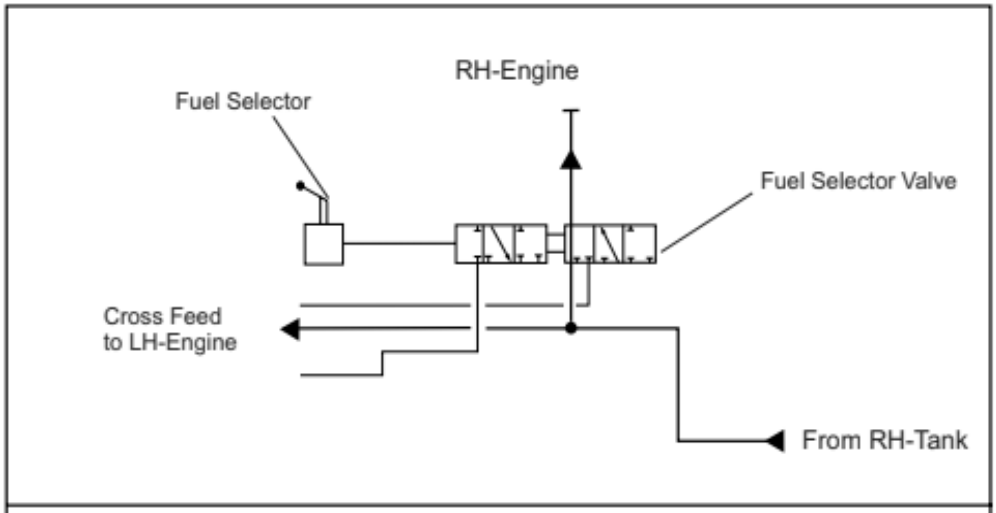
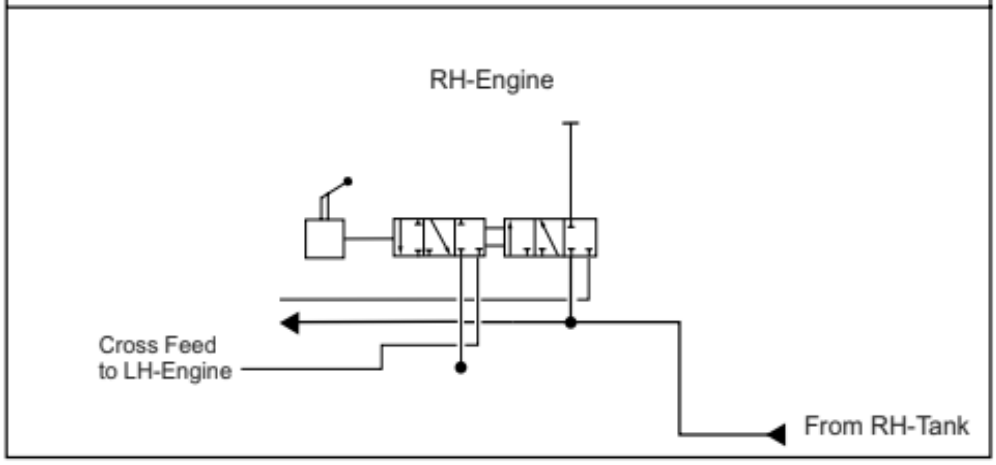


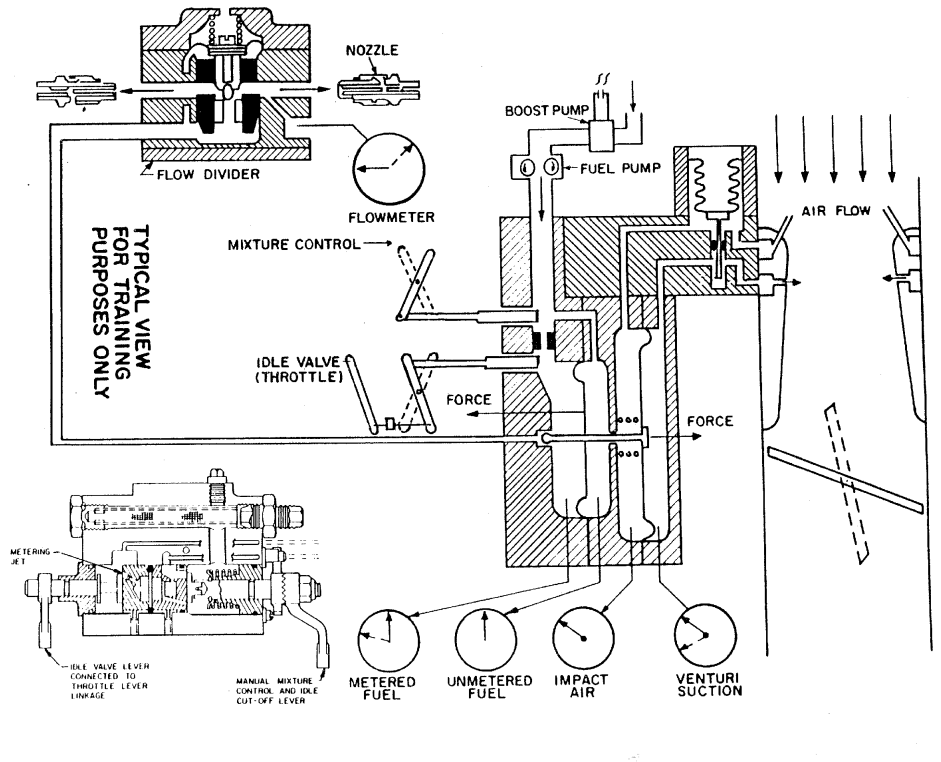
Figure 5:

RH Fuel Selector Valve in shut-off position, LH valve in cross-feed position



Fuel Injected Engines

1. Describe a typical fuel injection system
2. Describes how it works
3. Describe how the system can fail
4. Describe how the system may be restored to functionality



-22-

Figure 13.

LA-8514

G1000 System is Integrated into the DA-42 – You must be able to:

1. Explain the G1000 system is used in the DA-42 to include the units that generate the information and where and how the information is displayed. This includes but is not limited to:
    a. a. AHRS
    b. b. ADC
    c. c. Transponder
    d. d. GPS Units
    e. e. Autopilot
    f. f. VORs
2. Explain how the systems can fail.
3. Explain how the emergency checklist can help solve any problems.

Pitot-Static/ADC System – You must be able to:

1. Draw a schematic of the pitot-static system
2. Explain how the system works.
3. Explain how the system can fail.
4. Explain how the emergency checklist can help solve any problems.

Navigation Systems – You must be able to:

1. Describe the navigation systems (VOR, LOC, ILS, GPS)
2. Explain how each system works, its tolerances and where the information is displayed.
3. Explain how the systems can fail.
4. Explain how the emergency checklist can help solve any problems.

Describe the information displayed on the HSI and how to use it.

Inflight

1. 1. Align the heading bug to every heading that you plan or are directed to fly.
   • For example, if setting up for power on stalls heading 120°, set the heading bug on 120.
2. If you are doing a VFR approach to a runway, set the HSI course needle to the runway heading that you plan on landing on.
   • For example, if coming into land at Stinson Airport and told to expect runway 14 then set the course arrow needle to 140°.

Flight Control System – You must be able to:

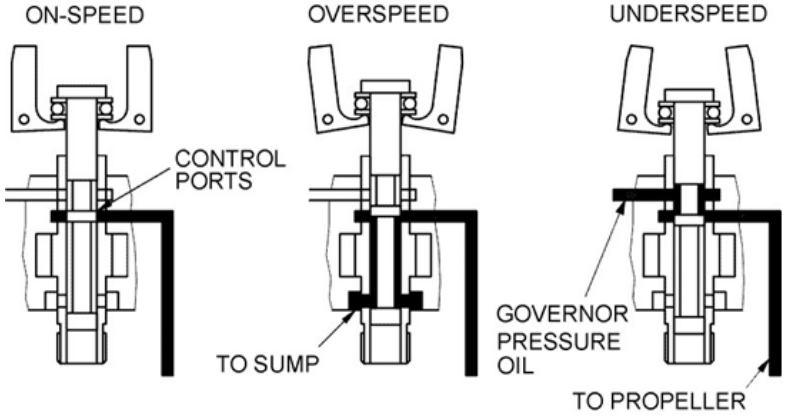
1. Explain how the flight controls work.
2. Explain how the trim works.
3. Explain how the control stick limiting system works.
4. Explain how the system can fail.
5. Explain how the emergency checklist can help solve any problems.

Power Plants – You must be able to:

1. Describe the engines on the DA-42
2. Explain how they work & the power they provide to the airplane.
3. Explain how they can fail.
4. Explain how the emergency checklist can help solve any problems.

Propeller Governor – You must be to:

1. Sketch the propeller governor system for a multi-engine airplane.
2. Explain how the system works.
3. Explain how the system can fail.
4. Explain how the emergency checklist can help solve any problems.



Multi Engine Aerodynamics – You must be able to explain to Commercial Pilot ACS

1. Critical Engine
   a. What it means
   b. How it is determined
2. V_{MC}
   a. What it means
   b. How & under what conditions it is determined
3. Single-engine aerodynamics
4. Zero sideslip

Heating, Ventilation and Defrosting System – You must be able to:

1. Describe how the heating, ventilation and defrosting system works
2. Explain how the system can fail.
3. Explain how the emergency checklist can help solve any problems.

Ice Protection System – You must be able to:

1. Describe ice protection systems
2. Explain how the systems work (or would work if installed).
3. Explain how the systems can fail.
4. Explain how the emergency checklist could help solve any problems

Weight & Balance – You must:

1. Know how to perform a weight & balance calculations
2. Be able to perform and explain a shift change in CG.
3. Be able to explain what happens to the aircraft if you overload it.
4. Be able to explain zero fuel weight and what can happen if you exceed it.
5. Be able to explain how the CG affects aircraft performance.

Performance Charts – You must be able to:

1. Calculate aircraft performance using the charts in the AFM & Checklist.
2. Calculate T.O.L.D., Accelerate Stop distance, O.E.I. climb performance/ceiling.
3. Explain the aircraft performance that you find in the charts and graphs.
4. Explain how performance is affected with contaminated runways.

Commercial Pilot Airman Certification Standards – You must be able to explain:

1. What is required of you as a Commercial Pilot taking the practical exam.
2. All the items required in the Oral portion of the practical exam.
3. All items you are required to perform during the flight portion of the practical exam.

Aeronautical Decision Making

1. You must be able to plan out the maneuvers that need to be flown for the checkride. This should be demonstrated on each flight.
2. You must demonstrate "Crew Resource Management" as a single pilot on each flight.
3. <u>You must use the aircraft checklist!</u>

<u>Multi-Engine Maneuvers</u>

You and your instructor will work on these together. By the completion of this course, you will be expected describe, set-up, and execute each maneuver to Multiengine Commercial ACS.

Normal Takeoff

1. Flaps – UP
2. Roll out onto runway centerline
3. Hold Brakes & set power to 2200RPM
4. Check engine instruments (all within limits)
5. Release Brakes & apply full power
6. Call out "airspeed alive"
7. Rotate at V_R
8. Call out, "Positive rate, Gear – UP"
9. Accelerate to Blue Line
10. Climb at Blue Line until reaching 500 ft. AGL then perform climb checklist.

Climb

1. Pitch for Cruise Climb (90-105)
2. Power - 25”
3. RPM – 2500
4. Fuel Pumps – OFF, ***<u>One at a Time</u>***!
5. Landing Lights – OFF

Practice Area Cruise Checklist

1. Power – 20-22”
2. RPM – 2400
3. Mixtures – LEAN <u>100F Rich of Peak</u>
4. Fuel Pumps – OFF, ***<u>One at a Time</u>***!

Steep Turns

1. Set Power - ~18”
2. Slow to V_A 126 KIAS by performing clearing turns
3. Fuel Pumps – ON
4. Roll into a coordinated 50^O bank: through 30^O increase power to ~2” & increase back pressure to hold altitude. Use TRIM!!!!!
5. Begin rollout about 20^O before entry heading and use slight forward pressure on the stick to maintain altitude.
6. Roll into a coordinated steep turn in the opposite direction.
7. Begin rollout about 20^O before entry heading using forward pressure to maintain altitude & trim out the back pressure.
8. Practice Area Cruise Checklist.

Slow Flight

1. Clearing turns or use Steep Turns to clear for this maneuver.
2. Set power to ~17” & trim to maintain altitude
3. “Before Landing Checklist” GUMPF
    a. **G**as - Fuel Pumps & Fuel Selectors – ON
    b. **U**ndercarriage - Gear – DOWN below V_{LOE}. When gear down: Call out ***“3 green & 1 in the mirror.”***
    c. **M**ixture – LEAVE AT 100^o RICH OF PEAK or FULL RICH
    d. **P**rops – FULL FORWARD
    e. **F**laps – Incrementally extended to LDG and TRIM!
4. Slow to no slower than V_{MC}
5. Pitch for airspeed & power for altitude
6. Execute turns left and right as directed
7. Recovery:
    a. Full Power
    b. Nose on the horizon
    c. Flaps - Incrementally to UP
    d. Establish Blue Line
    e. Gear – UP below V_{LOR}
8. Cruise Checklist

Power Off Stalls

1. Clearing turns (use to reduce airspeed) or can be entered from slow flight.
2. Power set to ~17" & trim to maintain altitude
3. "Before Landing Checklist" GUMPF
    a. **G**as - Fuel Pumps & Fuel Selectors – ON
    a. **U**ndercarriage - Gear – DOWN below V_{LO}. When gear down: Call out ***"3 green & 1 in the mirror."***
    b. **M**ixture – LEAVE AT 100º RICH OF PEAK or FULL RICH
    c. **P**rops – FULL FORWARD
    d. **F**laps – Incrementally to LDG
4. Establish a stabilized descent (85)
5. Raise nose to horizon while simultaneously reducing power to idle
6. Stall – Recognize (Buffet, Stall Horn, Descent)
7. Recovery:
    a. Full Power
    b. Nose down to gain flying airspeed (no lower than ½ sky, ½ ground)
    c. Flaps – APP
    d. Nose on the horizon
    e. Flaps - UP
    f. Establish Blue Line
    g. Gear – UP below V_{LOR}
8. Cruise Checklist

Power-On Stalls

1. Set power ~15" & trim to maintain altitude
2. Use clearing turns to bleed off airspeed
3. Clean configuration Flow Checklist:
    a. Fuel Selectors – ON
    b. Mixtures – LEAVE AT 100º RICH OF PEAK or FULL RICH
    c. Props – 2400 RPM or Full Forward
    d. Fuel Pumps – ON
4. Slow to V_R 78 KIAS
5. Pitch up to vents on the horizon line no more than 20^O. (Bank airplane if directed by instructor or DPE, Not more than 20^O)
6. Power – 23"
7. Stall – Recognize
8. Recovery:
    a. Aircraft nose – LOWER to the horizon preferably but no lower than ½ sky ½ ground to regain airspeed.
    b. Full Power
    c. Nose – back to the horizon
    d. At Blue Line return to entry altitude
9. Practice Area Cruise Checklist

Accelerated Stalls

1. Set power ~15" & trim to maintain altitude
2. Use clearing turns to bleed off airspeed
3. Clean configuration Flow Checklist:
    a. Fuel Selectors – ON MAINS
    b. Mixtures – LEAVE AT 100º RICH OF PEAK or FULL RICH
    c. Props – 2400
    d. Fuel Pumps – ON
4. Slow to 85 KIAS
5. Bank airplane to 45^{O} and pull slowly to stall horn.
6. Stall – Recognize (Horn)
7. Recovery:
    a. Stick – Forward (Release back pressure)
    b. Aircraft – Roll out (Use rudder & aileron)
    c. Power - Full
    d. Nose – back to the horizon
    e. Establish aircraft in level flight
8. Practice Area Cruise Checklist

V_{MC} Demonstration

1. Clear the area
2. Clean configuration Flow Checklist:
    a. Fuel Selectors – ON
    b. Mixtures – LEAVE AT 100º RICH OF PEAK or FULL RICH
    c. Props – Full Forward
    d. Fuel Pumps – ON
    e. Throttles – FULL FORWARD
3. "Slowly & smoothly" reduce left throttle to idle
4. Establish Zero Sideslip
    a. $< 5^{O}$ of bank to the right engine
    b. Split the brick in the turn coordinator ½ way into the good side of the triangle or the ball on the standby attitude indicator
    c. Slow to within 10 KIAS of Blue Line
    d. Ensure full Power on right Engine
    e. Maintain direction control with rudder and use aileron to hold bank
    f. Pitch up to reduce airspeed by 1 KIAS per second until the first sign of loss of
        i. Directional control,
        ii. Maximum rudder deflection (hit the stop)
        iii. Stall warning or Buffet
5. Recovery:
    a. Lower aircraft nose & Reduce power on right engine
    b. Maintain directional control $\pm 20^{O}$ of heading from entry
    c. Once directional control is established; full power on the right engine and re-establish 90 KIAS (Blue Line)
6. Once restabilized – Maneuver complete. "Scissor" both throttles back to cruise.
7. Practice area cruise checklist

Emergency Descent

1. Fuel Pumps - ON
2. Throttles - Idle
3. Below V_{LOE} – Gear Down
4. Mixtures –LEAVE AT 100º RICH OF PEAK or FULL RICH
5. Props – Full Forward
6. Nose Down – Below V_{NO} 155 KIAS
7. Shallow turns to clear for traffic below
8. Begin to start level off at 10% of the descent rate and not later than 250 feet above target altitude.
9. Once level at altitude and at or below V_{LOR} 156 KIAS - Gear – UP
10. Practice area cruise checklist.

Normal Landing

1. Set ~18" (100 KIAS) entering downwind (depending on weight & OAT)
2. Select a touchdown point.
3. Midfield downwind set ~15" MP & perform "Before Landing Checklist" GUMPF
    a. **G**as - Fuel Pumps & Fuel Selectors – ON
    b. **U**ndercarriage - Gear – DOWN below $V_{LOE.}$ "3 green & 1 in the mirror."
    c. **M**ixture – LEAVE AT 100º RICH OF PEAK or FULL RICH
    d. **P**rops – FULL FORWARD
    e. **F**laps – APP
4. Airspeed V_{YSE} (90 KIAS)
5. Base – Flaps LDG; Airspeed - Blue Line, recheck gear down.
6. Final – Approach Speed Set **85KIAS (V_{REF})**
7. ***At 400 ft. AGL, call out "Gear Down, 1 in the mirror Stabilized, 85"***
   If this call is not made, you will be directed to go-around!
8. Smoothly reduce power to enter ground effect
9. Touchdown main wheels first
10. Gently lower nose wheel

Short Field Takeoff

1. Use all available runway
2. Hold Brakes & set power to 2200 RPM
3. Check engine instruments (all within limits)
4. Full Power & Release Brakes
5. Call out "airspeed alive"
6. Rotate at 78
7. Climb at V_X – 85 KIAS
8. After clearing 50 ft. obstacle, accelerate to Blue Line (90 V_{YSE})
9. When out of available runway, Gear – UP
10. Climb at Blue Line until reaching 500 ft. AGL then perform climb checklist.

Short field Landing

1. Set ~18" (100 KIAS) entering downwind (depending on weight & OAT)
2. Select a touchdown point.
3. Midfield downwind set ~15" MP & perform "Before Landing Checklist" GUMPF
    a. **G**as - Fuel Pumps & Fuel Selectors – ON
    b. **U**ndercarriage - Gear – DOWN below $V_{LOE.}$ "3 green & 1 in the mirror."
    c. **M**ixture – LEAVE AT 100º RICH OF PEAK or FULL RICH
    d. **P**rops – FULL FORWARD
    e. **F**laps – APP
4. Airspeed V_{YSE} (90 KIAS)
5. Base – Flaps LDG; Airspeed - Blue Line, recheck gear down.
6. Final – Approach Speed Set **85 KIAS (V_{REF})**
7. ***At 400 ft. AGL, call out "Gear Down, 1 in the mirror Stabilized, 85"***
   If this call is not made, you will be directed to go-around!
8. Touchdown at or within 100 ft. of selected point at the slowest possible airspeed. (Do Not Stall Aircraft)
9. Power – IDLE
10. Gently lower nose wheel.
11. Back pressure to put weight on main wheels
12. Simulate max braking. ***(Do Not Lock Brakes & Skid Wheels)***

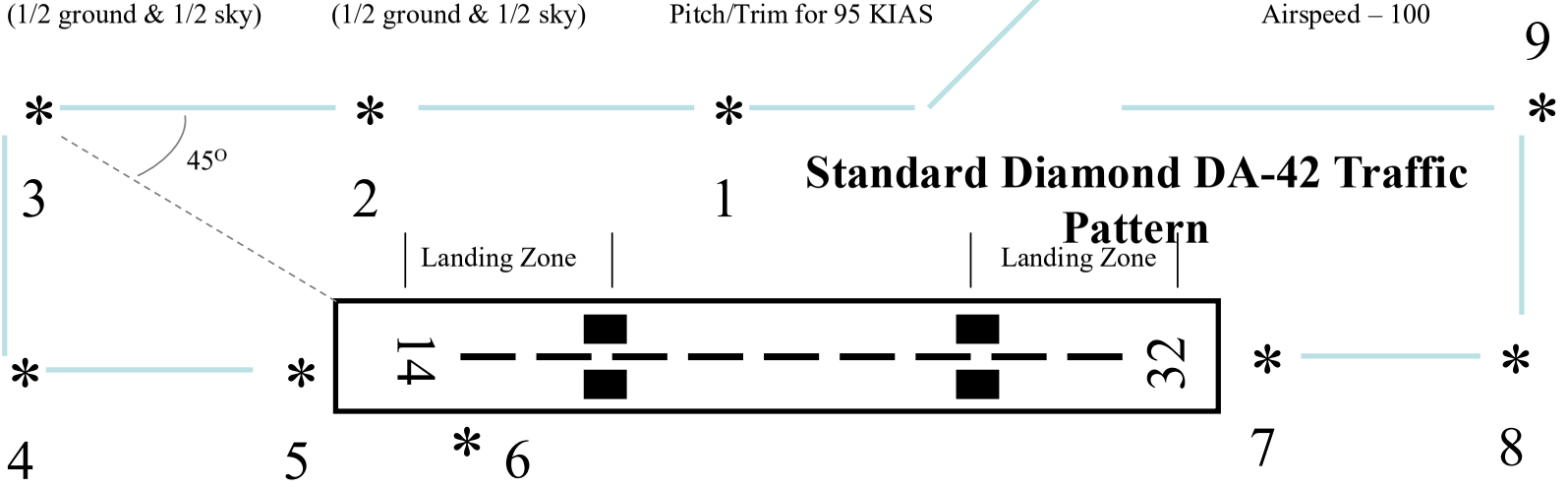
3. **Base** (After Roll Out)
   Flaps – Ldg
   Throttles ≃ 21" in. MP
   Pitch/Trim for 95 KIAS
   (1/2 ground & 1/2 sky)

2. **Abeam Numbers**
   Flaps –APP
   Throttles ≃ 21" in. MP
   Pitch/Trim for 95 KIAS
   (1/2 ground & 1/2 sky)

1. **Midfield**
   Throttle ≃ 18" MP
   Mixture – Rich (A/R)
   Props – Full Forward
   Pitch/Trim for 95 KIAS

45° Degree Entry to Downwind 85 KIAS

9. **Downwind**
   Pattern Attitude
   Throttles – 22 in. MP
   Flaps UP
   Airspeed – 100



4. **Final**
   Roll out aligned with Rwy C_L
   Airspeed - 85 KIAS
   Throttles- as required

5. **Landing Criteria**
   Landing assured on 1st 3rd of Rwy
   Acft will land on Rwy C_L
   Acft Long. Axis Aligned with Rwy C_L
   Airspeed - 85 KIAS V_{REF}
   Aim Point visible until flare

6. **Go Around**
   Power - FULL
   Establish Climb Attitude
   Nose on the Horizon
   Flaps – APP
   Climb at V_X – 85 KIAS until 50 ft AGL
   Establish normal Climb V_Y – 90 KIAS

7. **Departure Leg**
   Pitch/Trim for V_Y - 90
   Throttle - Full
   Flaps – UP at 400'AGL
   Climb - 90 KIAS

8. **Cross wind**
   Turn @300ft below pattern altitude
   Throttle - Full
   Climb – 90 KIAS