Area of Operation **III** - Task **D**

Performance and Limitations

Content

westflying

Key References:
- Airplane Flying Handbook
- Pilot's Handbook of Aeronautical Knowledge
- POH/AFM

1. Introduction

- **What**: Operating data about airplane's capabilities for Takeoff, climb, range/endurance, descent, and landing
- **Why**: Safe operations of the aircraft
- **Atmospheric Conditions**
  - Lower Pressure ➔ *Lower Air Density*
  - Higher Altitude ➔ *Lower Air Density*
  - Higher Temperature ➔ *Lower Air Density*
  - Higher Humidity ➔ *Lower Density*
  - Lower Air density ➔ Worse Performance
    - ***High, Hot, Humid***
- **Airplane's Weight and Balance (W&B)**
  - Higher Weight ➔ Worse Performance
  - Further Forward CG ➔ Worse Performance (slightly)

Telluride Regional (KTEX), Colorado: 9,078ft elevation

- **Operating limitations are in Chapter 2 and Performance data on Chapter 5 of the POH**

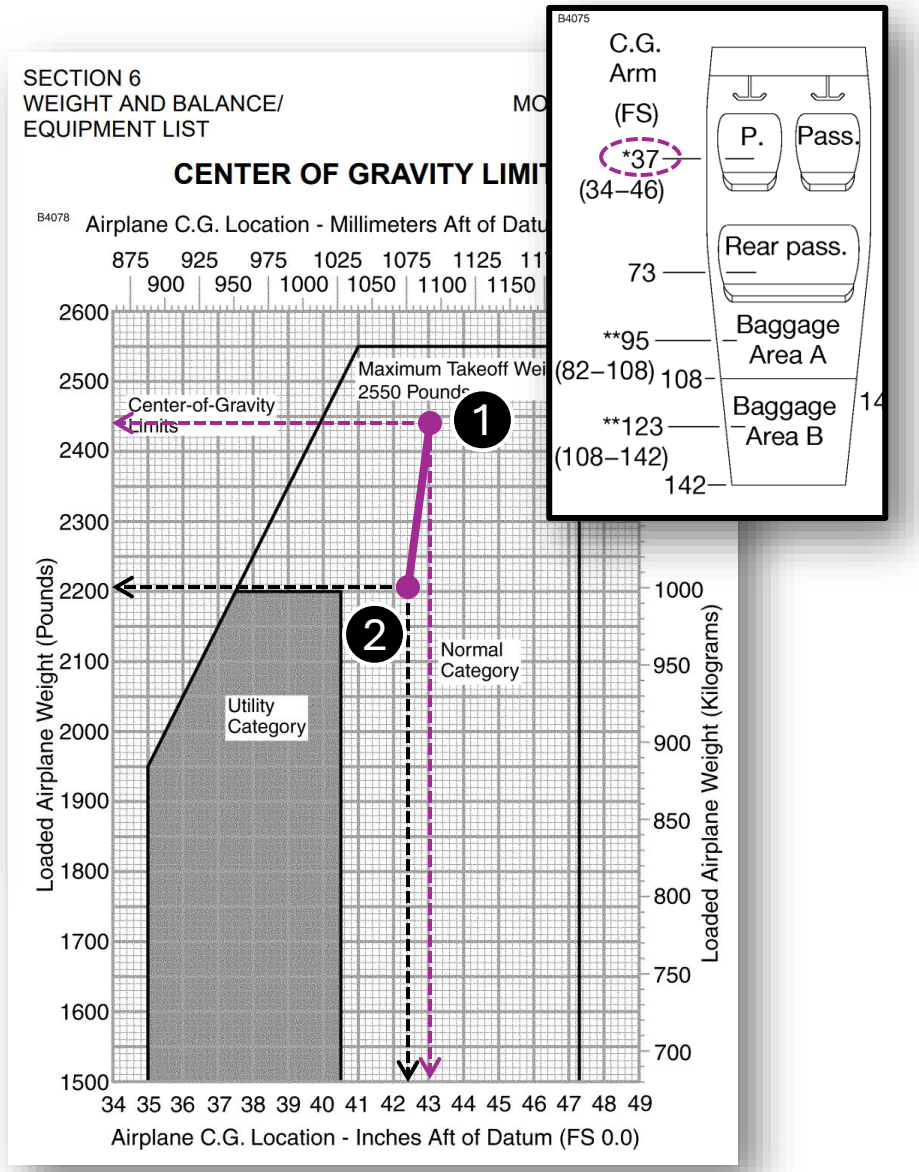
2. Weight & Balance

RAINIER FLIGHT SERVICE

N129K

	Weight	Arm/CG	Moment
Basic Empty Weight	1720.9	41.9	72156
Pilot	160 lb	34 – 46 37	5920
Pax 1	200 lb	34 – 46 37	7400
Pax 2		73	
Pax 3		73	
Fuel (318 lbs max)	53G x 6 = 318 lb	48	15264
Baggage Area 1 (120 lbs max)*	50 lb	95	4750
Baggage Area 2 (50 lbs max)*		123	
Ramp Weight (2558 lbs max)	2448.9 lb	43.1	105439.7
Taxi Burn	-1G x 6 = -6 lb	48	-288
Takeoff Weight (2550 lbs max) ①	2442.9 lb	43.0	105151.7
Enroute Burn	-40G x 6 = -240 lb	48	-11520
Landing Weight (2550 lbs max) ②	2202.9 lb	42.5	93631.7

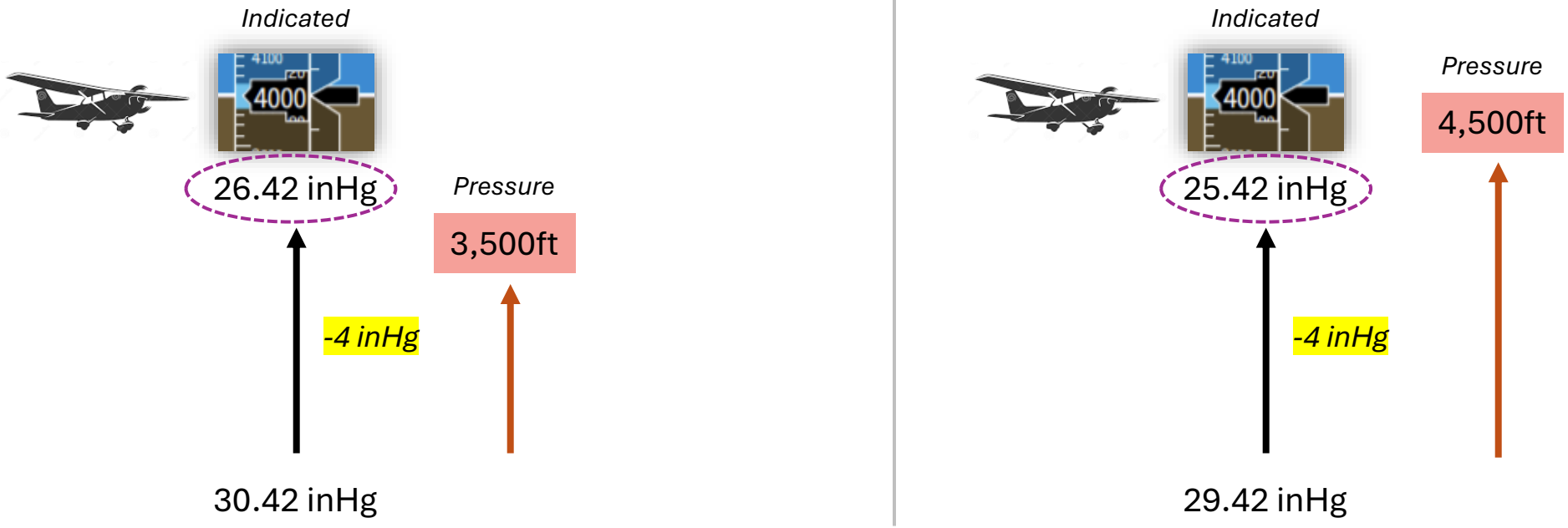
*120 lbs max combined weight both baggage areas



- **CG = Moment / Weight**
- Pilot must verity MTOW envelope
- Pilot must verify CG envelope

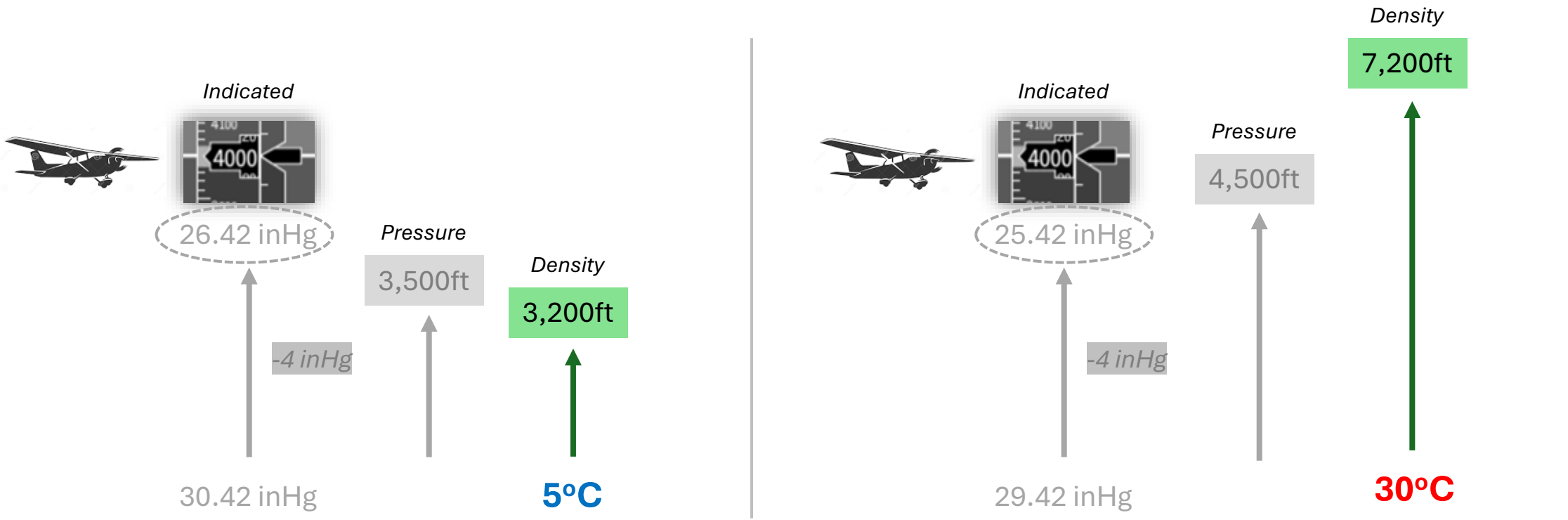
3. Atmospheric Conditions

- **Pressure Altitude**
  - Height above the standard datum plane (29.92 inHg) ➔ **PA (ft) = Indicated Alt (ft) + 1000 x (29.92 – Alt Setting)**
  - Used in Performance Data



3. Atmospheric Conditions

- **Density Altitude**
  - Pressure Altitude corrected for non-standard temperature ➔ **DA (ft) = PA (ft) + 120 x (OAT ΔISA ºC)**
  - The altitude the Airplane think it is (*High Density Altitude = Decreased Performance*)



4. Factors to be Considered on Performance

- **Airport Environment**
  - Soft Runway ➔ Increases takeoff rolls, decrease landing rolls
  - Wind ➔ Headwind decrease runway length required
  - Upsloping runway ➔ Increases takeoff rolls
  - Obstacles in the approach ➔ Increases runway required to clear
- **Airplane Configuration**
  - Flap setting, Lean Mixture, Use of fairings ➔ All interfere with calculated performance
- **Calculated vs Actual Performance**
  - Performance data in the POH is calculated using a New aircraft and "Average" pilot skills *(PHAK Chapter 11)*
  - Pilot skill ➔ Poor flying technique and/or poor ability to properly lean the aircraft will decrease performance
  - Aircraft condition ➔ Older engines, old/dirty airframe, all interfere with performance (not as good as a New aircraft)
- **Safety Margin**
  - Add your own safety margin (e.g. 20-50%) over calculated values

5. Performance Charts and Tables

Runway Required

- Paved, Level, Dry runway
- Temperature 18ºC, Headwind 9kts
- Field elevation 2,100 ft
- Altimeter 30.22 inHg
- Steps:
  1. Read the conditions
  2. Read the notes
  3. Calculate PA
  4. Find info in the table
  5. Apply corrections & Safety factor

PA = 2100 + 1000x(29.92-30.22)
PA = 2100 – 300 ➔ ***PA = 1900ft***

Takeoff (50ft) = 2035 – 10% ➔ ***1832ft***
Landing (50ft) = 1420 – 10% ➔ ***1278ft***

Then increase by a safety factor (e.g. 50%)

CESSNA
MODEL 172S NAV III
GFC 700 AFCS

SECTION 5
PERFORMANCE

SHORT FIELD TAKEOFF DISTANCE AT 2550 POUNDS

CONDITIONS:
Flaps 10°
Full Throttle prior to brake release.
Paved, Level, Dry Runway
Zero Wind

Lift Off: 51 KIAS
Speed at 50 Feet: 56 KIAS

Pressure Altitude Feet	0°C		10°C		20°C		30°C		40°C	
	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst
Sea Level	860	1465	925	1575	995	1690	1070	1810	1150	1945
1000	940	1600	1010	1720	1090	1850	1170	1990	1260	2135
2000	1025	1755	1110	1890	1195	2035	1285	2190	1380	2355
3000	1125	1925	1215	2080	1310	2240	1410	2420	1515	2605
4000	1235	2120	1335	2295	1440	2480	1550	2685	1660	2880
5000	1355	2345	1465	2545	1585	2755	1705	2975	1825	3205
6000	1495	2605	1615	2830	1745	3075	1875	3320	2010	3585
7000	1645	2910	1785	3170	1920	3440	2065	3730	2215	4045
8000	1820	3265	1970	3575	2120	3880	2280	4225	2450	4615

NOTE

- Short field technique as specified in Section 4.
- Prior to takeoff from fields above 3000 feet pressure altitude, the mixture should be leaned to give maximum RPM in a full throttle, static run-up.
- Decrease distances 10% for each 9 knots head wind. For operation with tail winds up to 10 knots, increase distances by 10% for each 2 knots.
- For operation on dry grass runway, increase distances by 15% of the "ground roll" figure.

SECTION 5
PERFORMANCE

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SHORT FIELD LANDING DISTANCE AT 2550 POUNDS

CONDITIONS:
Flaps FULL
Power IDLE
Maximum Braking

Zero Wind
Paved, Level, Dry Runway
Speed at 50 ft: 61 KIAS

Pressure Altitude Feet	0°C		10°C		20°C		30°C		40°C	
	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst
Sea Level	545	1290	565	1320	585	1350	605	1380	625	1415
1000	565	1320	585	1350	605	1385	625	1420	650	1450
2000	585	1355	610	1385	630	1420	650	1455	670	1490
3000	610	1385	630	1425	655	1460	675	1495	695	1530
4000	630	1425	655	1460	675	1495	700	1535	725	1570
5000	655	1460	680	1500	705	1535	725	1575	750	1615
6000	680	1500	705	1540	730	1580	755	1620	780	1660
7000	705	1545	730	1585	760	1625	785	1665	810	1705
8000	735	1585	760	1630	790	1670	815	1715	840	1755

NOTE

- Short field technique as specified in Section 4.
- Decrease distances 10% for each 9 knots head wind. For operation with tail winds up to 10 knots, increase distances by 10% for each 2 knots.
- For operation on dry grass runway, increase distances by 45% of the "ground roll" figure.
- If landing with flaps up, increase the approach speed by 9 KIAS and allow for 35% longer distances.

5. Performance Charts and Tables

- **Maximum Rate of Climb**
  - Important to calculate climb rate (e.g. Instrument Approaches)
- **Time, Fuel and Distance to Climb**
  - Important for TOC, Fuel Calculations, Clear obstacles, etc

Example:
Climb 2,000 → 6,000ft (PA) @ 2550lbs, 15°C

1. *Expect between 515-695 fpm*
2. *Expect:*
   - *10 – 3 = 7 minutes*
   - *2.2 – 0.8 = 1.4 Gal*
   - *13 – 4 = 9nm*
   - *4000ft in 7min = 571fpm*

1

MAXIMUM RATE OF CLIMB AT 2550 POUNDS

CONDITIONS:

Flaps UP
Full Throttle

Pressure Altitude Feet	Climb Speed - KIAS	Rate of Climb - FPM			
		-20°C	0°C	20°C	40°C
Sea Level	74	855	785	710	645
2000	73	760	695	625	560
4000	73	685	620	555	495
6000	73	575	515	450	390
8000	72	465	405	345	285
10,000	72	360	300	240	180
12,000	72	255	195	135	---

NOTE

Mixture leaned above 3000 feet pressure altitude for maximum RPM.

2

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SKYHAWK G1000 172S NAV III
GFC 700 AFCS

SECTION 5
PERFORMANCE

TIME, FUEL AND DISTANCE TO CLIMB AT 2550 POUNDS

CONDITIONS:
Flaps UP
Full Throttle
Standard Temperature

Pressure Altitude Feet	Temp °C	Climb Speed KIAS	Rate of Climb FPM	From Sea Level		
				Time Minutes	Fuel Used Gallons	Distance NM
Sea Level	15	74	730	0	0.0	0
1000	13	73	695	1	0.4	2
2000	11	73	655	3	0.8	4
3000	9	73	620	4	1.2	6
4000	7	73	600	6	1.5	8
5000	5	73	550	8	1.9	10
6000	3	73	505	10	2.2	13
7000	1	73	455	12	2.6	16
8000	-1	72	410	14	3.0	19
9000	-3	72	360	17	3.4	22
10,000	-5	72	315	20	3.9	27
11,000	-7	72	265	24	4.4	32
12,000	-9	72	220	28	5.0	38

NOTE

- Add 1.4 gallons of fuel for engine start, taxi and takeoff allowance.
- Mixture leaned above 3000 feet pressure altitude for maximum RPM.
- Increase time, fuel and distance by 10% for each 10°C above standard temperature.
- Distances shown are based on zero wind.

5. Performance Charts and Tables

SECTION 5
PERFORMANCE

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CRUISE PERFORMANCE

CONDITIONS:
2550 Pounds
Recommended Lean Mixture

Pressure Altitude Feet	RPM	20°C BELOW STANDARD TEMP			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2000	2550	83	117	11.1	77	118	10.5	72	117	9.9
	2500	78	115	10.6	73	115	9.9	68	115	9.4
	2400	69	111	9.6	64	110	9.0	60	109	8.5
	2300	61	105	8.6	57	104	8.1	53	102	7.7
	2200	53	99	7.7	50	97	7.3	47	95	6.9
	2100	47	92	6.9	44	90	6.6	42	89	6.3
4000	2600	83	120	11.1	77	120	10.4	72	119	9.8
	2550	79	118	10.6	73	117	9.9	68	117	9.4
	2500	74	115	10.1	69	115	9.5	64	114	8.9
	2400	65	110	9.1	61	109	8.5	57	107	8.1
	2300	58	104	8.2	54	102	7.7	51	101	7.3
	2200	51	98	7.4	48	96	7.0	45	94	6.7
	2100	45	91	6.6	42	89	6.4	40	87	6.1
6000	2650	83	122	11.1	77	122	10.4	72	121	9.8
	2600	78	120	10.6	73	119	9.9	68	118	9.4
	2500	70	115	9.6	65	114	9.0	60	112	8.5
	2400	62	109	8.6	57	108	8.2	54	106	7.7
	2300	54	103	7.8	51	101	7.4	48	99	7.0
	2200	48	96	7.1	45	94	6.7	43	92	6.4

NOTE

- Maximum cruise power using recommended lean mixture is 75% MCP. Power settings above 75% MCP are listed to aid interpolation. Operations above 75% MCP must use full rich mixture.
- Cruise speeds are shown for an airplane equipped with speed fairings. Without speed fairings, decrease speeds shown by 2 knots.

SECTION 5
PERFORMANCE

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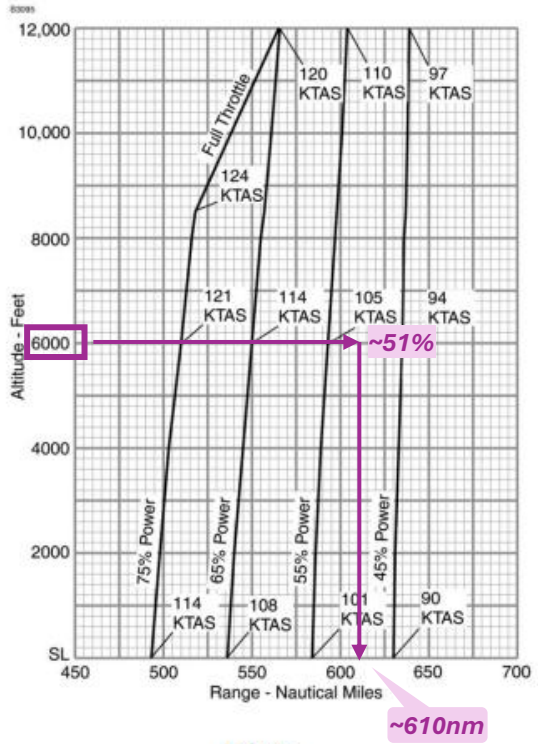
RANGE PROFILE
45 MINUTES RESERVE
53 GALLONS USABLE FUEL

CONDITIONS:
2550 Pounds
Recommended Lean Mixture for Cruise at all altitudes

Standard Temperature
Zero Wind



NOTE

- This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during a normal climb.
- Cruise speeds are shown for an airplane equipped with speed fairings. Without speed fairings, decrease speeds shown by 2 knots.

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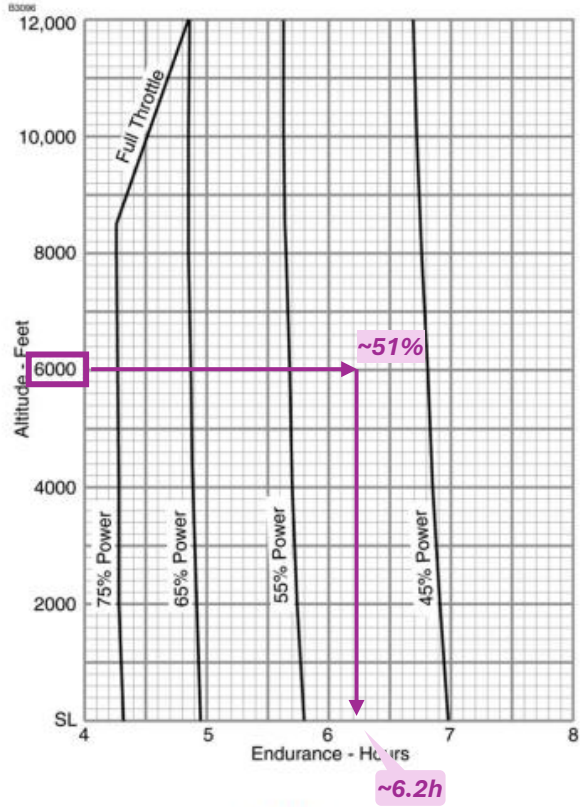
SECTION 5
PERFORMANCE

ENDURANCE PROFILE
45 MINUTES RESERVE
53 GALLONS USABLE FUEL

CONDITIONS:
2550 Pounds
Recommended Lean Mixture for Cruise at all altitudes

Standard Temperature



NOTE

This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the time during a normal climb.

6. Exceeding Limitations

- **Operating limitations are in Chapter 2 and Performance data on Chapter 5 of the POH**
- **Limitations establish boundaries for which the airplane can be safely operated**
- **Effects of Exceeding Limitations**
  - Attempting to takeoff or land without sufficient runway
    - ✓ *Can result in a crash in an obstacle and/or over-running the runway*
  - Attempting to clear an obstacle that performance will not support
    - ✓ *Can result in crash with the obstacle or stall*
  - Insufficient fuel to reach the intended airport
    - ✓ Can result in Emergency landing or ditching
  - Using the wrong type of fuel
    - ✓ *Causes detonation and/or engine failure*
  - Exceeding aerodynamic and/or structural limits (overweight or outside CG)
    - ✓ *Airplane damage, structural failure, undesired control and stability characteristics*
  - Exceeding maximum demonstrated crosswind component
    - ✓ *You would be the test pilot. Challenges to maintain runway alignment and control once on the ground*

Questions?