The National FAA Safety Team Presents

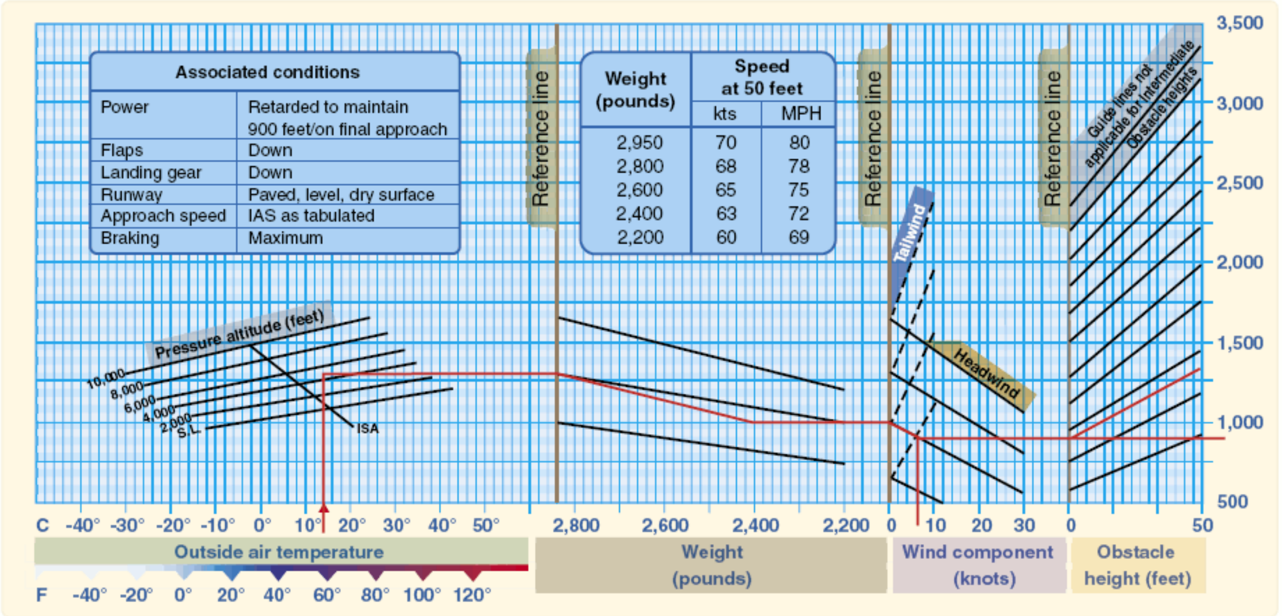
Topic of the Month—December

Aircraft Performance Calculations

Presented to: WAFC and Friends

By: Stephen Bateman, CFI

Date: Monday December 12th, 2022



Produced by:
The National FAA Safety Team (FAASTeam)

Federal Aviation Administration

Welcome

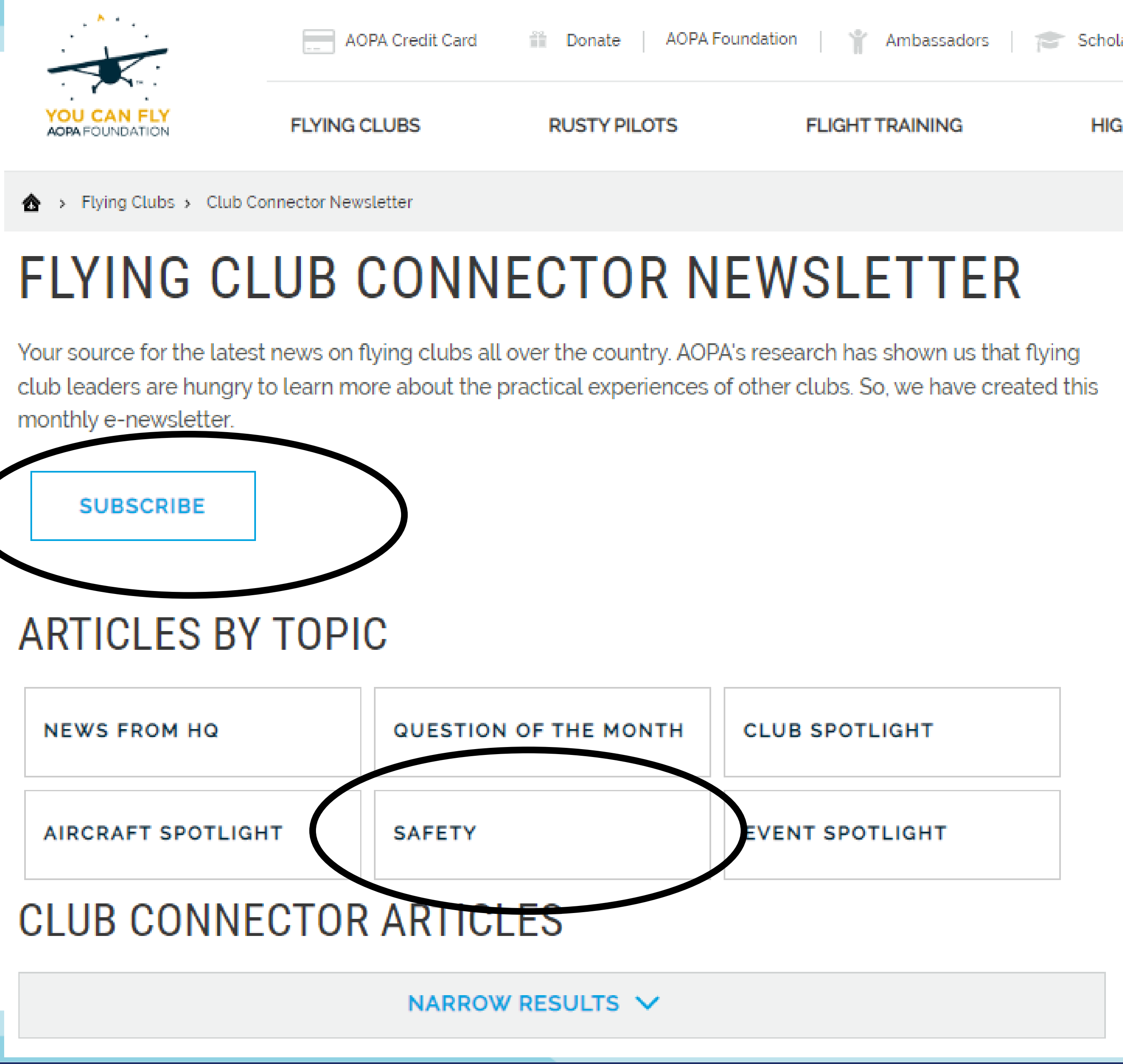
- **Steve Bateman, CFI, AOPA Director of Flying Clubs**
- **Our monthly 30-minute in-and-out safety meeting loosely based on the FAASTeam Topic of the Month**
- **WINGS Credit: Yes…but give me a day…**
- **Probably no time for questions, but please send me email:**

steve.bateman@aopa.org

The Westminster Aerobats Flying Club, Inc

So…

- **Is there a recoding of this webinar somewhere?**
  - No – I do not record these webinars
- **Can I get a copy of the slides?**
  - Yes!
  - This and earlier ToM presentations are available…
  - Sign up tonight!
  - Next edition 12/18




Check NOTAMS!

Aircraft Performance Calculations

- Why
- What
- How

Why…

Accidents occurring hot, high, humid and heavy situations led The General Aviation Joint Safety Committee (GAJSC) to study this in more detail and concluded that many of these accidents were caused by inaccurate and/or unreasonable expectations about aircraft performance

Accidents Involving Performance

Figure 1.11: Major types of accidents

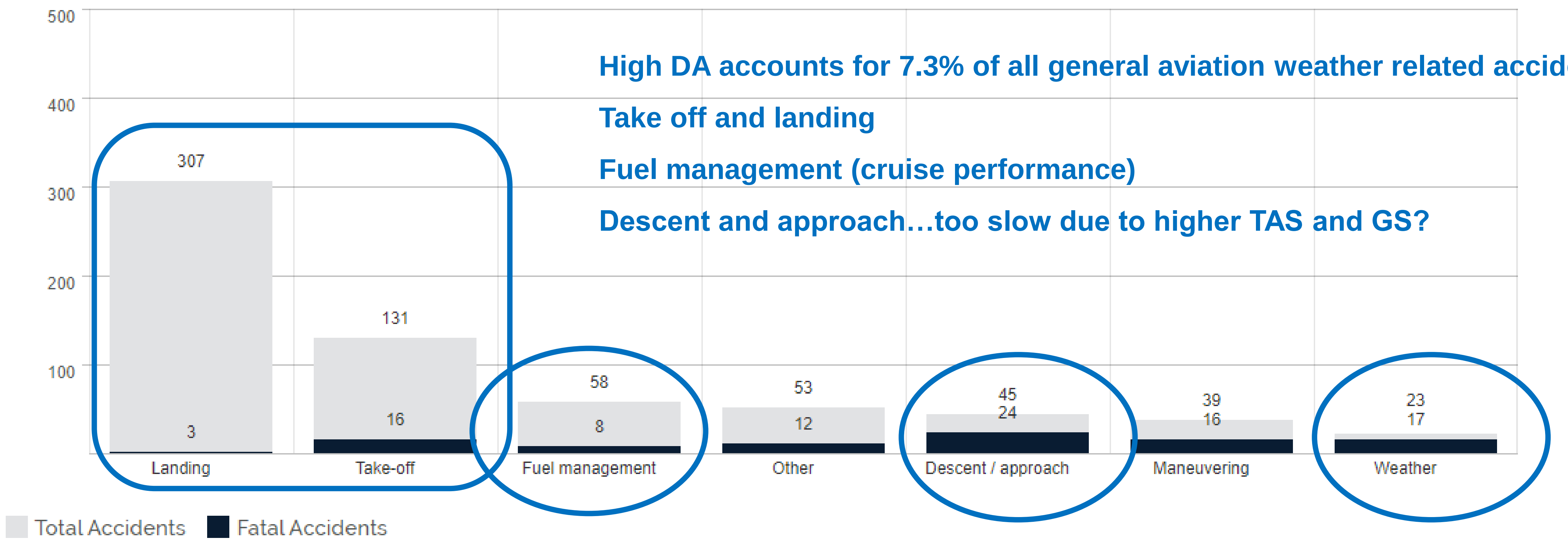
2020 Non-commercial fixed-wing

High DA accounts for 7.3% of all general aviation weather related accidents

Take off and landing

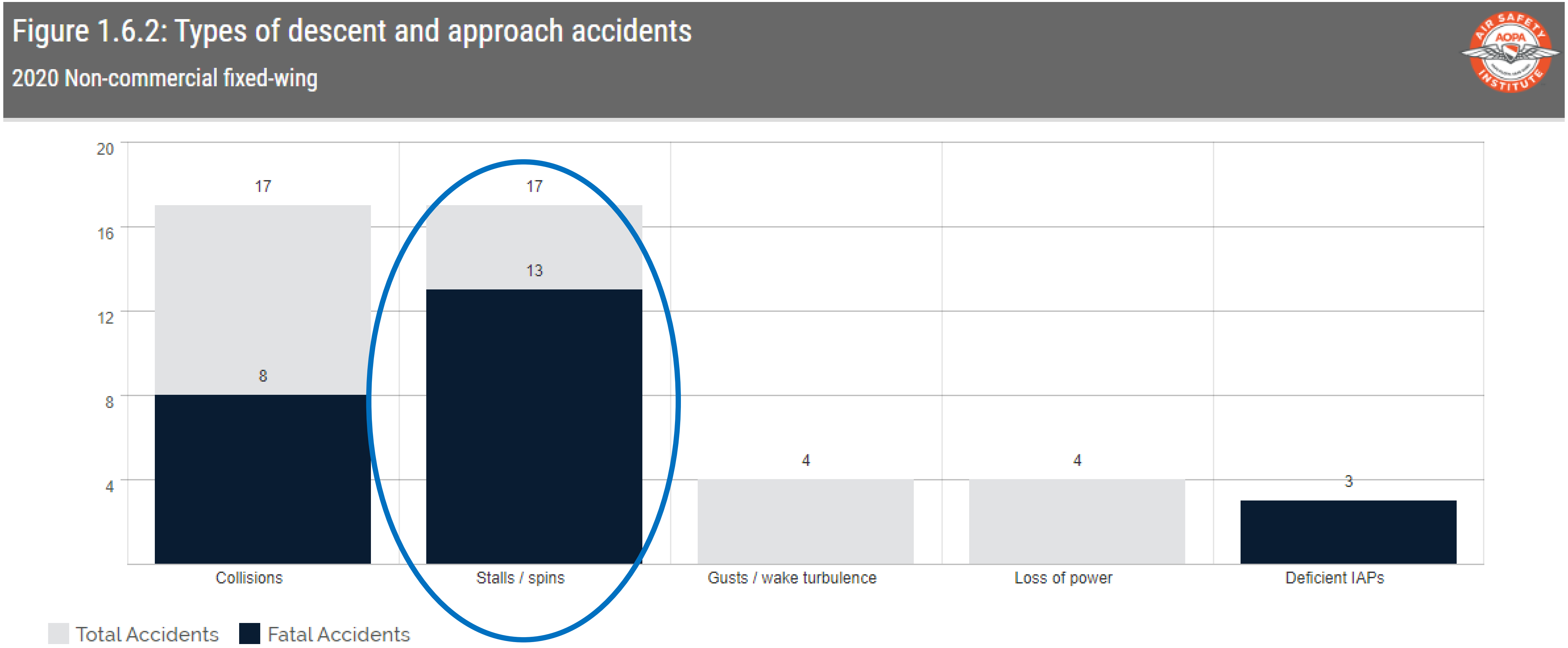
Fuel management (cruise performance)

Descent and approach…too slow due to higher TAS and GS?



Types of Take Off Accidents

Types Descent and Approach Accidents

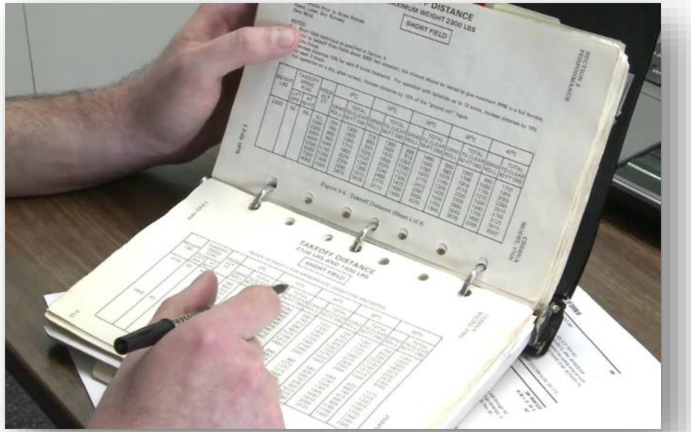


What: The Aviation 4-H Club

- **Hot**
  - Field temperature (take off and landing performance)
  - Temp at altitude (cruise performance)
- **High**
  - Altitude = lower air density
  - Low pressure day = lower air density
- **Humid**
  - Relative humidity
  - T & DP
  - Hot air can hold more water vapor = lower air density. (Clouds “float”)
- **Heavy**
  - More W means more L to get up and stay airborne
  - Where does “more L” come from?
  - Lift comes from V^2 and/or C_L (airspeed and/or AoA)

How often have you heard….

- She’ll haul anything you can fit in the door
- Relax - I flew it in here – I’ll fly it out
- We’ve got plenty of fuel…(umm…perhaps too much?)

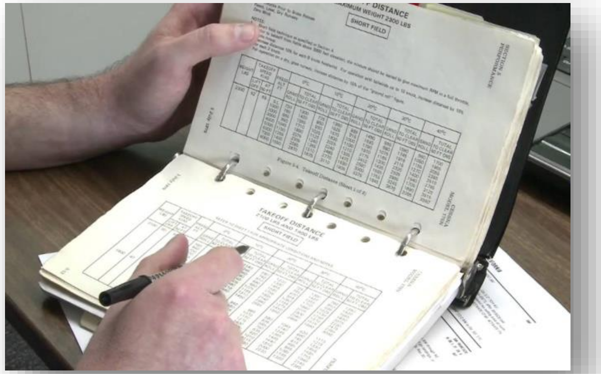


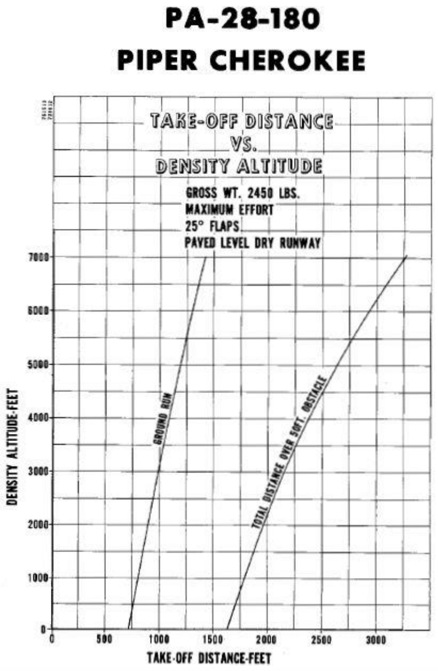
Pilots need to know – performance calculations

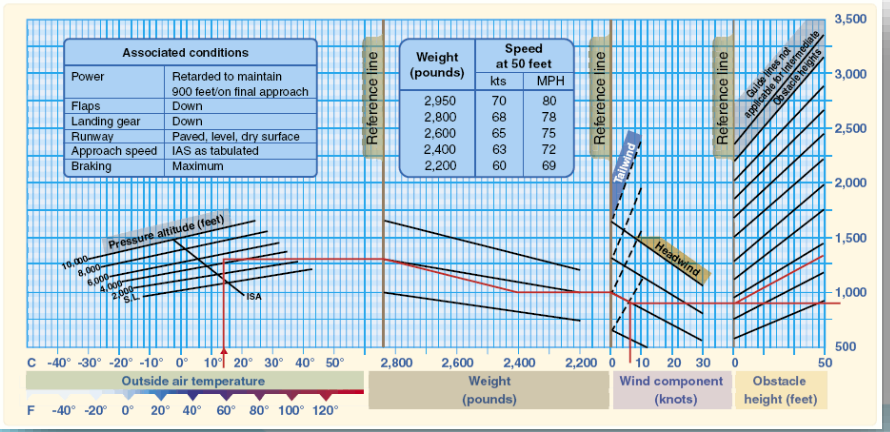
- **Weight and balance**
  - Don’t guess it—weigh it!
  - Location, location, location
  - Objects may shift in flight…

Pilots need to know – performance calculations

- **DA and weight impacts:**
  - Take off distance
  - Landing distance
  - Climb performance & obstacle clearance
  - Cruise performance
- **Runway length, composition, condition and slope**
  - Take off distance
  - Landing distance
- **Aircraft configuration**
  - Normal, short field, soft field
  - Flap settings



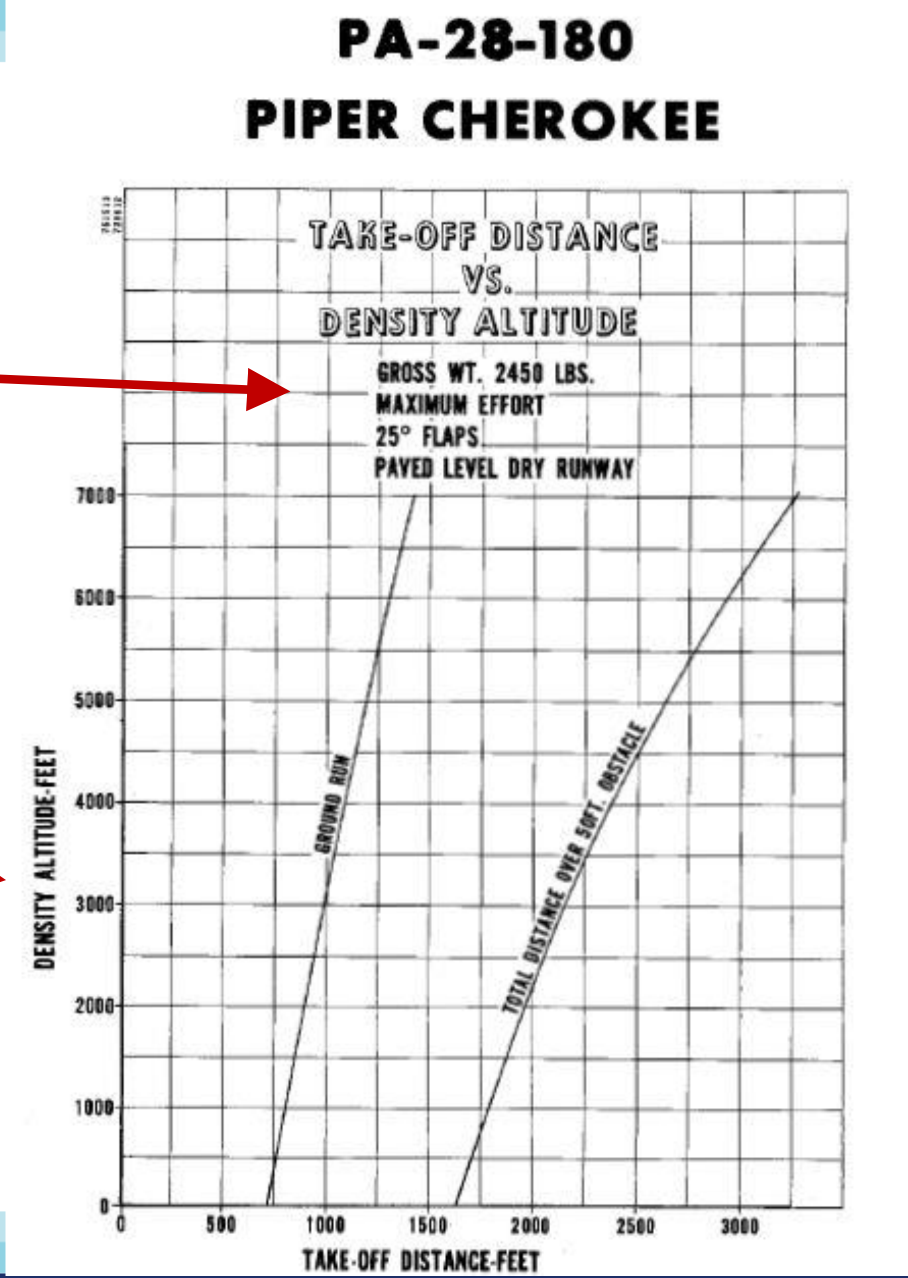




Take off calculations

– It's all about DA and weight
– Stated conditions…

– Need to know DA and weight for this Piper table



Take off calculations

- It's all about DA and weight
- Need to know PA, temp & weight for this Cessna table
- Read the conditions and notes!

CONDITIONS:

Flaps 10°
Full Throttle Prior to Brake Release
Paved, level, dry runway
Zero Wind
Lift Off: 51 KIAS
Speed at 50 Ft: 56 KIAS

NOTES:

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

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 Ft: 56 KIAS

Press Alt In Feet	0°C		10°C		20°C		30°C		40°C	
	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst
S. L.	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

NOTES:

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

Figure 5-5. Short Field Takeoff Distance (Sheet 1 of 3)

Same aircraft…different conditions

SECTION 5
PERFORMANCE

CESSNA
MODEL 172S

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 Ft: 56 KIAS

Press Alt In Feet	0°C Grnd Roll Ft	0°C Total Ft To Clear 50 Ft Obst	10°C Grnd Roll Ft	10°C Total Ft To Clear 50 Ft Obst	20°C Grnd Roll Ft	20°C Total Ft To Clear 50 Ft Obst	30°C Grnd Roll Ft	30°C Total Ft To Clear 50 Ft Obst	40°C Grnd Roll Ft	40°C Total Ft To Clear 50 Ft Obst
S. L.	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

NOTES:

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

Figure 5-5. Short Field Takeoff Distance (Sheet 1 of 3)

Impact of weight →

Impact of DA

(PA and Temp)

SECTION 5
PERFORMANCE

CESSNA
MODEL 172S

SHORT FIELD TAKEOFF DISTANCE
AT 2200 POUNDS

CONDITIONS:

Flaps 10°
Full Throttle Prior to Brake Release
Paved, level, dry runway
Zero Wind
Lift Off: 44 KIAS
Speed at 50 Ft: 50 KIAS

Press Alt In Feet	0°C Grnd Roll Ft	0°C Total Ft To Clear 50 Ft Obst	10°C Grnd Roll Ft	10°C Total Ft To Clear 50 Ft Obst	20°C Grnd Roll Ft	20°C Total Ft To Clear 50 Ft Obst	30°C Grnd Roll Ft	30°C Total Ft To Clear 50 Ft Obst	40°C Grnd Roll Ft	40°C Total Ft To Clear 50 Ft Obst
S. L.	610	1055	655	1130	705	1205	760	1290	815	1380
1000	665	1145	720	1230	770	1315	830	1410	890	1505
2000	725	1250	785	1340	845	1435	905	1540	975	1650
3000	795	1365	860	1465	925	1570	995	1685	1065	1805
4000	870	1490	940	1605	1010	1725	1090	1855	1165	1975
5000	955	1635	1030	1765	1110	1900	1195	2035	1275	2175
6000	1050	1800	1130	1940	1220	2090	1310	2240	1400	2395
7000	1150	1985	1245	2145	1340	2305	1435	2475	1540	2650
8000	1270	2195	1370	2375	1475	2555	1580	2745	1695	2950

NOTES:

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

Figure 5-5. Short Field Takeoff Distance (Sheet 3 of 3)

Recommendations:

- **Brief each takeoff, approach, and landing**
  - Helps reduce impact of startle
  - Performance expectations
  - Runway and available distance for takeoff or landing
  - Aircraft configuration and target airspeeds
  - Rejected takeoff or landing decision point
  - Departure/approach path
  - Obstacles and terrain
  - Return to airport altitude
  - Forced landing prospects

Recommendations:

- **Brief each takeoff, approach, and landing**
- **Take off and landing data (TOLD Card):**

Take-Off & Landing Distance Card - (See DA Graph)

Airplane Type: **Tail Number:** **Date:**

ATIS/WX Data:	**Value:**	**Comments:**
Date:		
Time:		
Airport:		
Info ID:		
Mag. Wind:		Headwind comp = WV*Cos(α)
Viz:		
Sky:		
Temp:		
Dew point:		
Altimeter:		
Expected runway:		
Runway length:		
Remarks:		
Calculated Data:	**Value:**	**Comments:**
Pressure Altitude.		
Density Altitude:		See DA table.
Take-off distances:		See PoH page: Take-off conditions:
a. Ground roll:		
b. To clear 50ft:		
c. TO speed IAS (V_R):		
d. V_X speed IAS (V_X):		
e. TO speed @ 50ft:		
f. Accel. stop distance: (2.5 x TO roll):		
Climb rate:		See PoH page:
a. Rate of Climb (FPM):		
b. Climb IAS (V_Y):		
Landing distances:		Conditions: See PoH page:
a. Ground roll:		
b. To clear 50ft:		
c. Landing speed @ 50ft:		
Hydroplane speed: SQRT(PSI)*9	50 40	At 30PSI. At 20PSI.

Note: Note: Take care with sign (+/-) of wind and field condition fiddle factors.

Take off rule of thumb

- **Rejected take off decision point**
  - 70/50 rule
  - By 50% (distance) be at 70% (speed)
  - Say V_R = 60 kts (indicated)
  - If take off distance available = 2,500’
  - Be at 42 kts by 1,250 feet

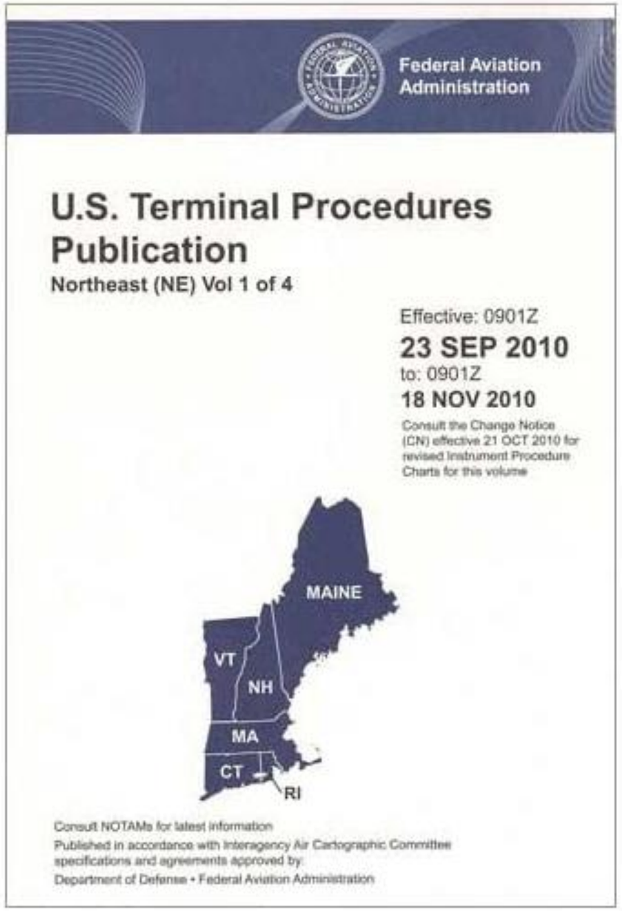
Pilots need to know

- Terrain and obstructions
- Forced landing challenges and opportunities

- Even if VFR, know the ODPs…

Take off and obstacle procedures are in the TPP

- **TPP: Terminal Procedures Publication**
- **Online**
  - Search for Digital TPP
  - https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dtpp/
- **Paper version**
- **A sort of Chart Supplement for instrument pilots**
- **Approach plates, STAR, SID…and more…**



Departure Procedures

- **Even if VFR, know the (IFR) *take off minimums***
- **Here, runway 12 requires a minimum climb of 410’ per NM to 800’**
- **Feet per NM?**
  - Yes - this is climb *gradient* (not rate)
- **We use this for instrument departures as we don’t want to hit things**
- **FPM = FPNM * GS/60**
- **At 90 knots, requires 615 FPM**
- **Can Betsy do it this, *today*?**
- **How do you know?**

L14

22307

TAKEOFF MINIMUMS, (OBSTACLE) DEPARTURE PROCEDURES, AND DIVERSE VECTOR AREA (RADAR VECTORS)

FREDERICK, MD
FREDERICK MUNI (FDK)
TAKEOFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES
AMDT 4A 30JAN20 (20030) (FAA)

TAKEOFF MINIMUMS:
Rwy 5, 300-2 or std. w/min. climb of 260' per NM to 600.
Rwy 12, 500-2¾ or std. w/min. climb of 410' per NM to 800.
Rwy 30, std. w/min. climb of 285' per NM to 900 or 1500-2½ for climb in visual conditions.

DEPARTURE PROCEDURE:
Rwy 5, climbing left turn heading 340° and on FDK VOR R-010 to 2100 before proceeding on course.
Rwy 12, climb heading 124° to 900 before proceeding westbound.
Rwy 23, climb heading 229° to 1200 before turning right.
Rwy 30, climbing right turn heading 040° and on FDK R-010 to 2400 before proceeding on course.

VCOA:
Rwy 30, obtain ATC approval for climb in visual conditions when requesting IFR clearance. Climb in visual conditions to cross Frederick Muni airport at or above 1700 before proceeding on course.

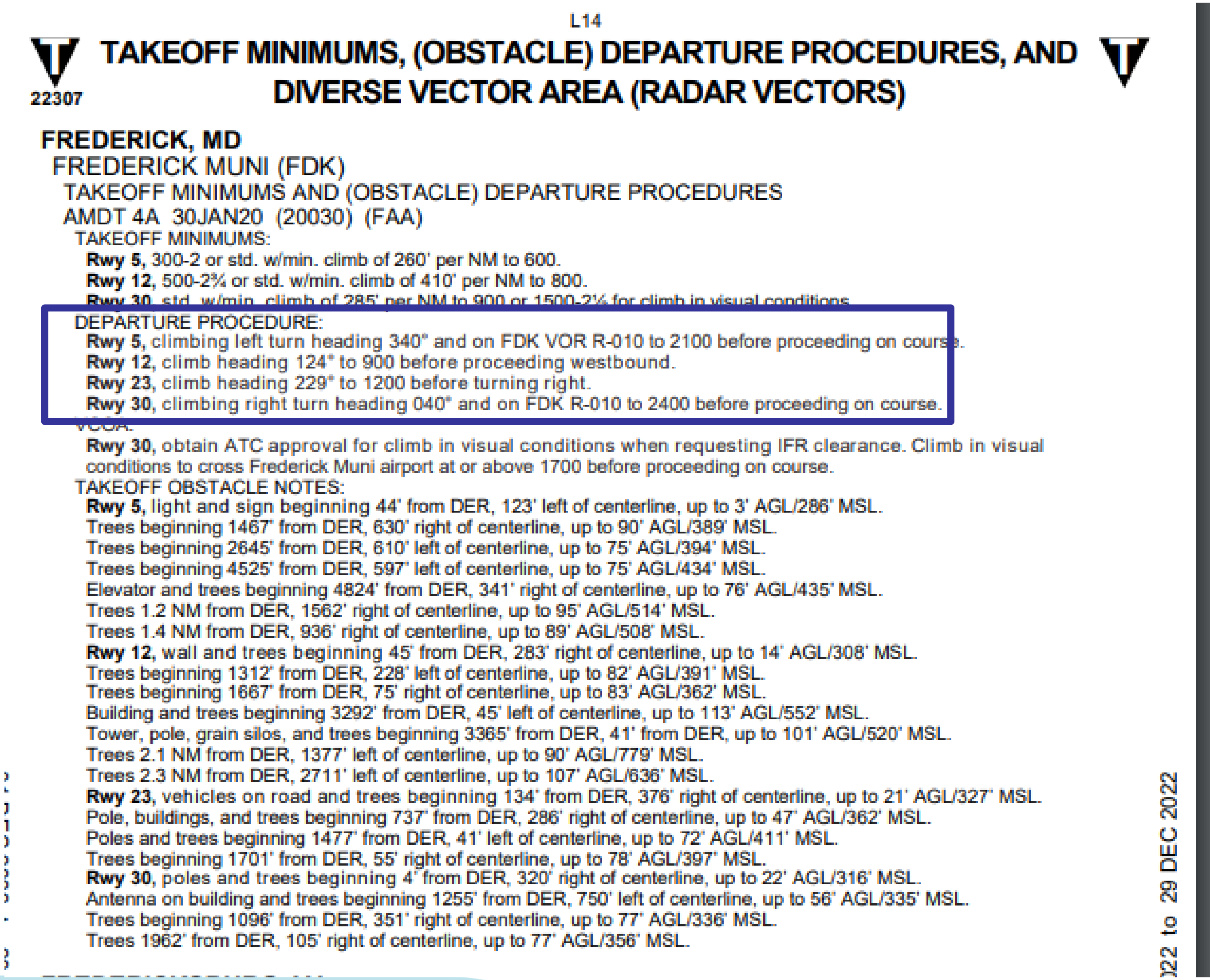
TAKEOFF OBSTACLE NOTES:
Rwy 5, light and sign beginning 44' from DER, 123' left of centerline, up to 3' AGL/286' MSL.
Trees beginning 1467' from DER, 630' right of centerline, up to 90' AGL/389' MSL.
Trees beginning 2645' from DER, 610' left of centerline, up to 75' AGL/394' MSL.
Trees beginning 4525' from DER, 597' left of centerline, up to 75' AGL/434' MSL.
Elevator and trees beginning 4824' from DER, 341' right of centerline, up to 76' AGL/435' MSL.
Trees 1.2 NM from DER, 1562' right of centerline, up to 95' AGL/514' MSL.
Trees 1.4 NM from DER, 936' right of centerline, up to 89' AGL/508' MSL.
Rwy 12, wall and trees beginning 45' from DER, 283' right of centerline, up to 14' AGL/308' MSL.
Trees beginning 1312' from DER, 228' left of centerline, up to 82' AGL/391' MSL.
Trees beginning 1667' from DER, 75' right of centerline, up to 83' AGL/362' MSL.
Building and trees beginning 3292' from DER, 45' left of centerline, up to 113' AGL/552' MSL.
Tower, pole, grain silos, and trees beginning 3365' from DER, 41' from DER, up to 101' AGL/520' MSL.
Trees 2.1 NM from DER, 1377' left of centerline, up to 90' AGL/779' MSL.
Trees 2.3 NM from DER, 2711' left of centerline, up to 107' AGL/636' MSL.
Rwy 23, vehicles on road and trees beginning 134' from DER, 376' right of centerline, up to 21' AGL/327' MSL.
Pole, buildings, and trees beginning 737' from DER, 286' right of centerline, up to 47' AGL/362' MSL.
Poles and trees beginning 1477' from DER, 41' left of centerline, up to 72' AGL/411' MSL.
Trees beginning 1701' from DER, 55' right of centerline, up to 78' AGL/397' MSL.
Rwy 30, poles and trees beginning 4' from DER, 320' right of centerline, up to 22' AGL/316' MSL.
Antenna on building and trees beginning 1255' from DER, 750' left of centerline, up to 56' AGL/335' MSL.
Trees beginning 1096' from DER, 351' right of centerline, up to 77' AGL/336' MSL.
Trees 1962' from DER, 105' right of centerline, up to 77' AGL/356' MSL.

22 to 29 DEC 2022

Departure Procedures

Departure Procedures

- **Even if VFR, know the *obstacle departure procedures***
- **Here, runway 12:**
  - Climb heading 124º to 900’ before proceeding westbound
  - Lots of notes to help you avoid hitting things…
- **So…we need to know take-off performance *AND* climb performance**



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TAKEOFF MINIMUMS, (OBSTACLE) DEPARTURE PROCEDURES, AND DIVERSE VECTOR AREA (RADAR VECTORS)

22307

FREDERICK, MD

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Rwy 30, std. w/min. climb of 285' per NM to 900 or 1500-2¼ for climb in visual conditions.

DEPARTURE PROCEDURE:

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Rwy 12, climb heading 124° to 900 before proceeding westbound.

Rwy 23, climb heading 229° to 1200 before turning right.

Rwy 30, climbing right turn heading 040° and on FDK R-010 to 2400 before proceeding on course.

VCOA:

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Rwy 23, vehicles on road and trees beginning 134' from DER, 376' right of centerline, up to 21' AGL/327' MSL.
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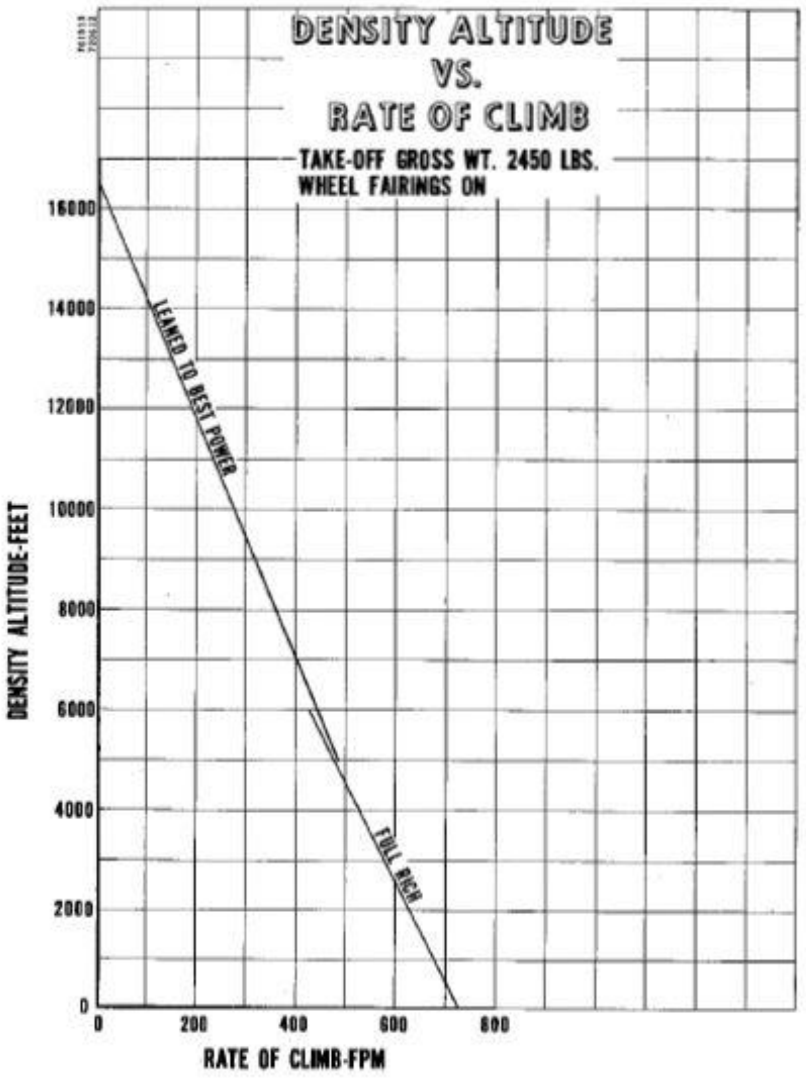
Antenna on building and trees beginning 1255' from DER, 750' left of centerline, up to 56' AGL/335' MSL.
Trees beginning 1096' from DER, 351' right of centerline, up to 77' AGL/336' MSL.
Trees 1962' from DER, 105' right of centerline, up to 77' AGL/356' MSL.

022 to 29 DEC 2022

Climb performance – DA and Weight

PA-28-180

PIPER CHEROKEE



MAXIMUM RATE-OF-CLIMB AT 2550 POUNDS

CONDITIONS:

Flaps Up
Full Throttle

PRESS ALT FT	CLIMB SPEED KIAS	RATE OF CLIMB - FPM			
		-20°C	0°C	20°C	40°C
S.L.	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:

1. Mixture leaned above 3,000 feet for maximum RPM.

Figure 5-6. Maximum Rate of Climb

Notes:

- **V_Y reduces with DA**
- **Rate of climb changes are significant**

Climb performance - leaning

Some planes have a climb leaning table

CESSNA
MODEL 172S

SECTION 5
PERFORMANCE

MAXIMUM RATE-OF-CLIMB AT 2550 POUNDS

CONDITIONS:

Flaps Up
Full Throttle

PRESS ALT FT	CLIMB SPEED KIAS	RATE OF CLIMB - FPM			
		-20°C	0°C	20°C	40°C
S.L.	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:

1. Mixture leaned above 3,000 feet for maximum RPM.

Figure 5-6. Maximum Rate of Climb

Note the note!

Lean above 3,000' (DA)

RATE OF CLIMB

CONDITIONS:
Flaps Up
Gear Up
2700 RPM
Full Throttle
Mixture Set at Placard Fuel Flow
Cowl Flaps Open

MIXTURE SETTING	
PRESS ALT	GPH
S. L.	17
4000	15
8000	13
12,000	10

WEIGHT LBS	PRESS ALT FT	CLIMB SPEED KIAS	RATE OF CLIMB – FPM			
			-20°C	0°C	20°C	40°C
2800	S.L.	82	1080	990	905	815
	2000	81	960	875	790	705
	4000	81	840	760	675	595
	6000	80	725	645	565	485
	8000	79	610	530	455	380
	10,000	79	495	420	350	- - -
	12,000	78	385	315	245	- - -

Weight, DA, Transition Training, Configuration

Aviation Investigation Final Report

Location:	Waterford, Michigan	**Accident Number:**	CEN13FA364
Date & Time:	June 21, 2013, 13:40 Local	**Registration:**	N9926Q
Aircraft:	Cessna 172M	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of control in flight	**Injuries:**	4 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

Air traffic control tower personnel saw the airplane lift off the runway and attain an altitude of about 100 feet. A pilot approaching the runway for landing saw the airplane lift off and noticed it was not climbing. He saw the airplane "lagging" and "wallowing in the air with flaps extended." Shortly after, the accident pilot advised an air traffic controller that he was "a little overweight" and would need to return to the airport and land. The air traffic controller cleared the airplane to land on the parallel runway or the grass area surrounding the runways. The pilot did not respond. Several witnesses near the airport, including the pilot in the landing airplane, saw the accident airplane impact the ground and burst into flames. A postaccident examination revealed that the wing flaps were fully extended (40 degrees). Weight and balance calculations indicated the airplane was slightly under maximum gross weight. Postaccident examinations revealed no evidence of preimpact mechanical malfunctions or failures that would have precluded normal operation.

Field at 981’, 28C, 30.17”
DA = 2,500’

Estimated gross weight 2,298.5 pounds
Maximum allowable gross weight 2,300 pounds

Time, Fuel and Distance to Climb

TIME, FUEL, AND DISTANCE TO CLIMB

MAXIMUM RATE OF CLIMB

CONDITIONS:
Flaps Up
Gear Up
2700 RPM
Full Throttle
Mixture Set at Placard Fuel Flow
Cowl Flaps Open
Standard Temperature

MIXTURE SETTING	
PRESS ALT	GPH
S.L.	17
4000	15
8000	13
12,000	10

NOTES:
1. Add 1.5 gallons of fuel for engine start, taxi and takeoff allowance.
2. Increase time, fuel and distance by 10% for each 10°C above standard temperature.
3. Distances shown are based on zero wind.

WEIGHT LBS	PRESSURE ALTITUDE FT	TEMP °C	CLIMB SPEED KIAS	RATE OF CLIMB FPM	FROM SEA LEVEL		
					TIME MIN	FUEL USED GALLONS	DISTANCE NM
2800	S.L.	15	82	925	0	0	0
	1000	13	82	875	1	0.3	2
	2000	11	81	830	2	0.6	3
	3000	9	81	780	4	1.0	5
	4000	7	81	730	5	1.3	7
	5000	5	80	685	6	1.6	9
	6000	3	80	635	8	2.0	11
	7000	1	80	585	10	2.4	14
	8000	-1	79	535	11	2.8	17
	9000	-3	79	490	13	3.2	20
	10,000	-5	79	440	16	3.6	23
	11,000	-7	78	390	18	4.1	27
	12,000	-9	78	345	21	4.6	31

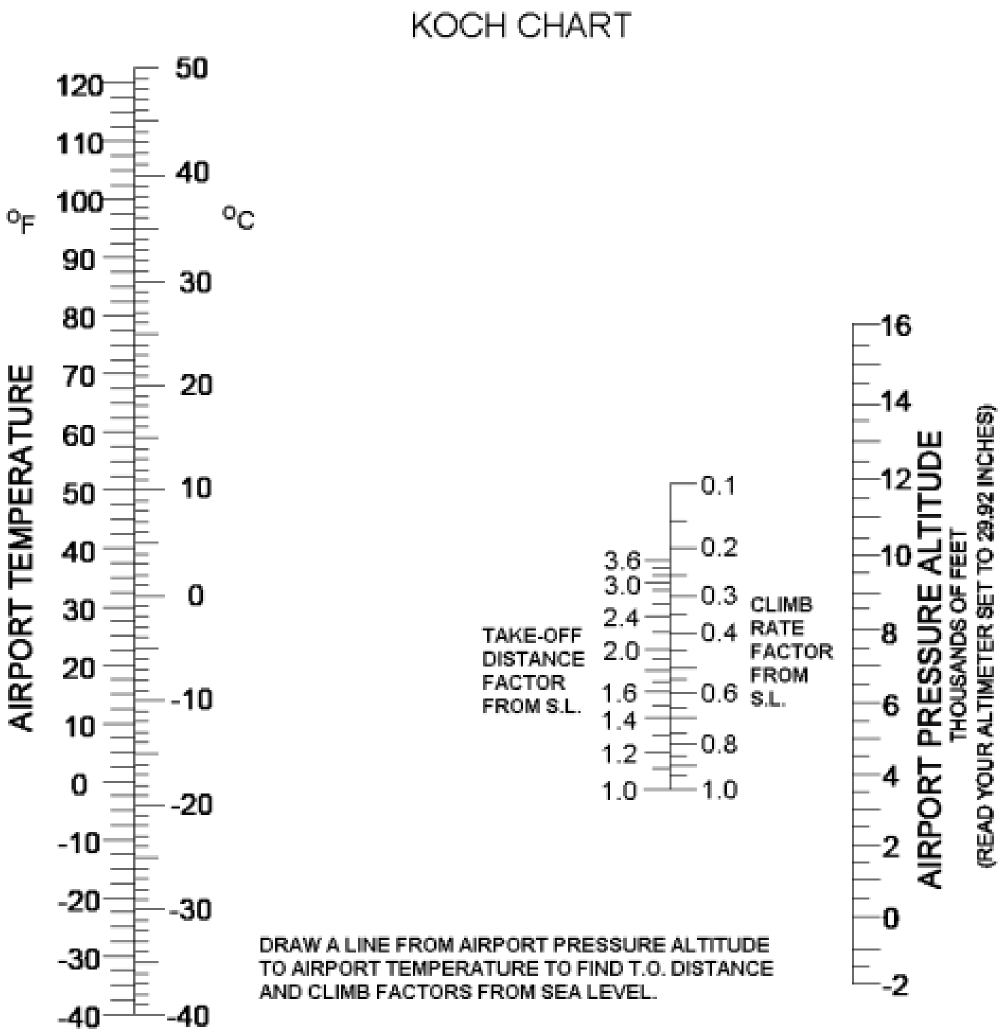
- **Read the notes!**
- **To determine values when climbing from say 3,000’ to say 8,000’**
  - Get the 8,000’ values
  - Subtract the 3,000’ values

Example

- **Climbing from an airport at 3,000’ to 8,000’ in standard conditions:**

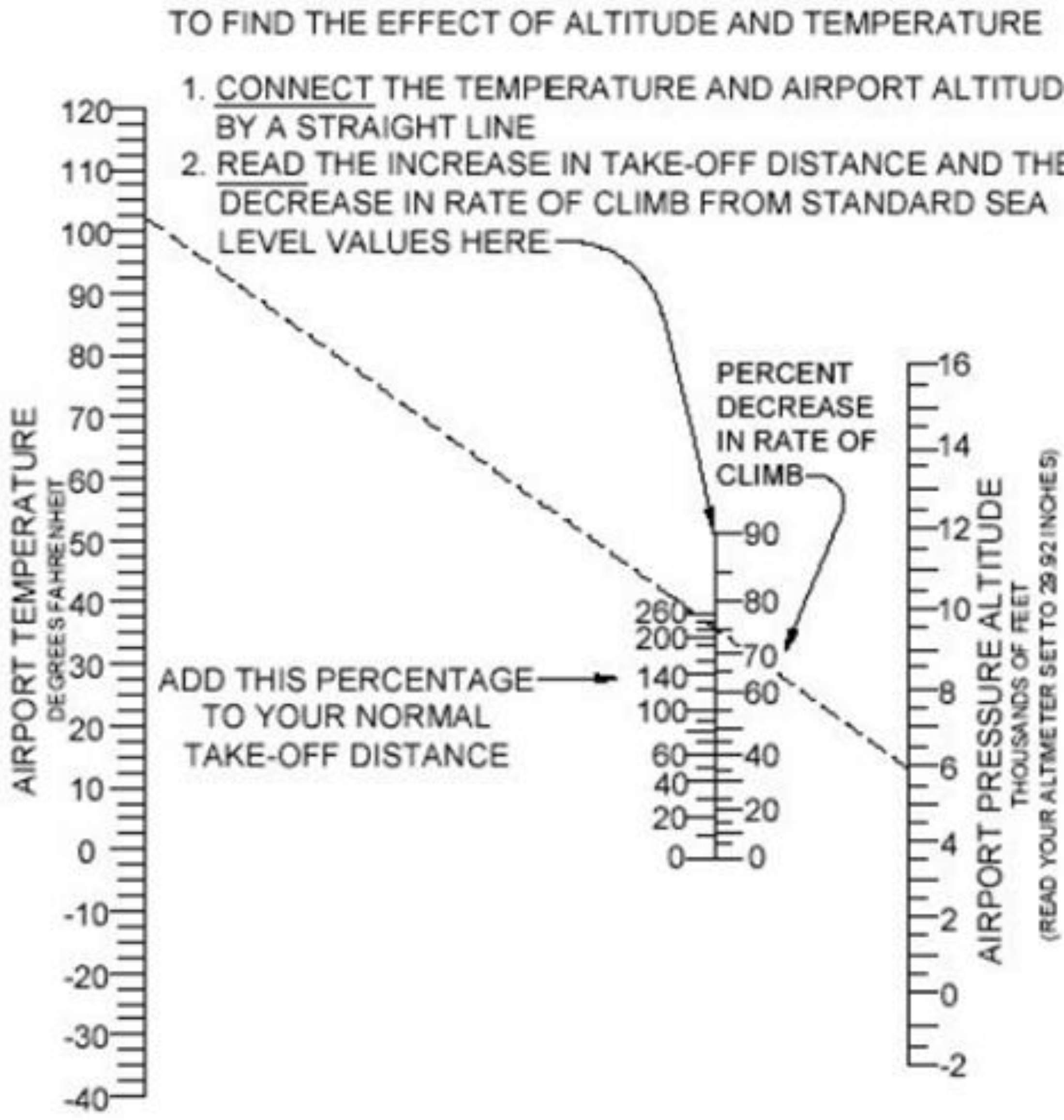
(2.8 – 1.0) + 1.5 = 3.3 gallons
11-4 = 7 minutes
17-5 = 12NM
RoC ~ 650 FPM
IAS ~ 80 knots

Koch Chart


KOCH CHART
°F
°C
AIRPORT TEMPERATURE
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
50
40
30
20
10
0
-10
-20
-30
-40
TAKE-OFF DISTANCE FACTOR FROM S.L.
3.6
3.0
2.4
2.0
1.6
1.4
1.2
1.0
0.1
0.2
0.3
0.4
0.6
0.8
1.0
CLIMB RATE FACTOR FROM S.L.
AIRPORT PRESSURE ALTITUDE
THOUSANDS OF FEET
(READ YOUR ALTIMETER SET TO 29.92 INCHES)
16
14
12
10
8
6
4
2
0
-2
DRAW A LINE FROM AIRPORT PRESSURE ALTITUDE TO AIRPORT TEMPERATURE TO FIND T.O. DISTANCE AND CLIMB FACTORS FROM SEA LEVEL.

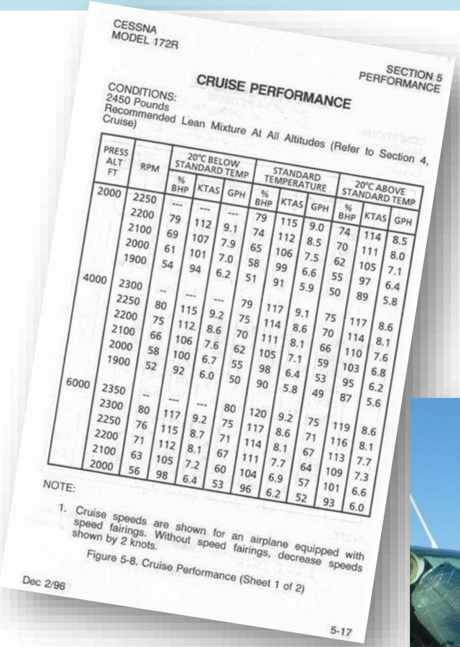
Example:

- For example, the diagonal line shows that 230 percent must be added for a temperature of 100F and a pressure altitude of 6,000 feet.
- Therefore, if your standard temperature sea level takeoff distance normally requires 1,000 feet of runway to climb to 50 feet, it would become 3,300 feet under the conditions shown in the chart.
- In addition, the rate of climb would be decreased by 76 percent. Also, if your normal sea level rate of climb is 500 FPM, it would become 120 FPM.



Cruise performance

- **Power setting & fuel consumption**
- **Altitude, wind, & ground speed**
- **En-route fuel usage and availability**
  - Confirm “time in your tanks” hourly
  - How much are we using?
  - Fuel management (both? L&R?)
- **Don’t wait to land & refuel**
  - Too easy to press on
- **Don’t land with less than one hour of fuel**


CESSNA
MODEL 172R

SECTION 5
PERFORMANCE

CRUISE PERFORMANCE

CONDITIONS:
2450 Pounds
Recommended Lean Mixture At All Altitudes (Refer to Section 4, Cruise)

PRESS ALT FT	RPM	20°C BELOW STANDARD TEMP			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
		% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH
2000	2250	---	---	---	79	115	9.0	74	114	8.5
	2200	79	112	9.1	74	112	8.5	70	111	8.0
	2100	69	107	7.9	65	106	7.5	62	105	7.1
	2000	61	101	7.0	58	99	6.6	55	97	6.4
	1900	54	94	6.2	51	91	5.9	50	89	5.8
4000	2300	--	---	---	79	117	9.1	75	117	8.6
	2250	80	115	9.2	75	114	8.6	70	114	8.1
	2200	75	112	8.6	70	111	8.1	66	110	7.6
	2100	66	106	7.6	62	105	7.1	59	103	6.8
	2000	58	100	6.7	55	98	6.4	53	95	6.2
	1900	52	92	6.0	50	90	5.8	49	87	5.6
6000	2350	--	---	---	80	120	9.2	75	119	8.6
	2300	80	117	9.2	75	117	8.6	71	116	8.1
	2250	76	115	8.7	71	114	8.1	67	113	7.7
	2200	71	112	8.1	67	111	7.7	64	109	7.3
	2100	63	105	7.2	60	104	6.9	57	101	6.6
	2000	56	98	6.4	53	96	6.2	52	93	6.0

NOTE:

1. Cruise speeds are shown for an airplane equipped with speed fairings. Without speed fairings, decrease speeds shown by 2 knots.

Figure 5-8. Cruise Performance (Sheet 1 of 2)

Dec 2/96

5-17

Cruise performance

- **Relative to std temp, not actual temp at altitude**
- **Standard temp at x feet**

  15 – (x/1000 * 2)

  At 4,000’ std temp = 7C

  If temps aloft = 27C, use last set of columns

- **Lots of interpolation? Be sensible!**

CRUISE PERFORMANCE

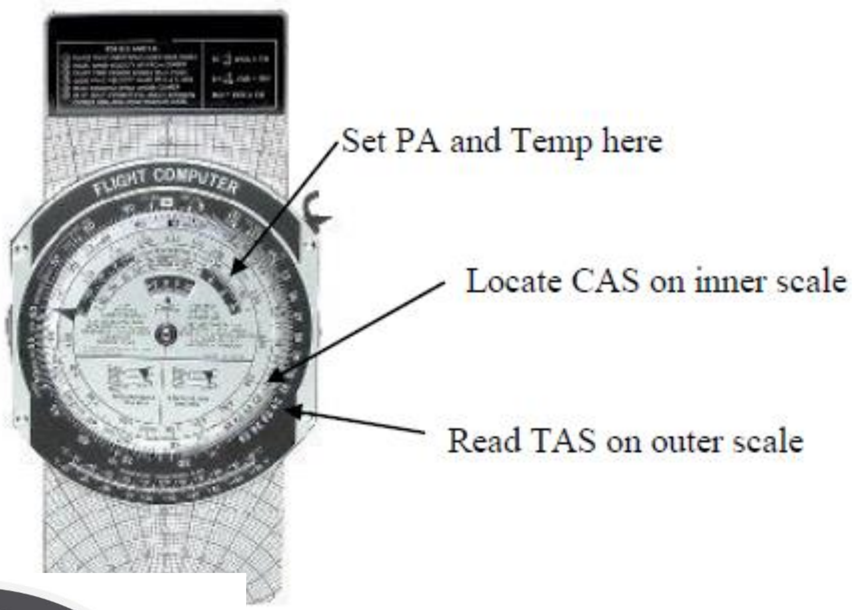
CONDITIONS:
2550 Pounds
Recommended Lean Mixture At All Altitudes (Refer to Section 4, Cruise)

PRESS ALT FT	RPM	20°C BELOW STANDARD TEMP			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
		% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	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

Figure 5-8. Cruise Performance (Sheet 1 of 2)

Cruise performance

- **Have TAS from cruise table**
- **At what IAS do we fly to get this TAS?**
- **How do you fly the actual TAS?**
  - Use your EFIS!
  - E6B - from DA and TAS, can get CAS
  - Rule of thumb:
  - For each 1,000’ of density altitude, add 2% CAS to get TAS
  - TAS ~ CAS*(1+0.02*DA/1000)
  - CAS ~ TAS/(1+0.02*DA/1000)
- **Some ASIs have a TAS scale**



Set PA and Temp

So…we need to know…DA (PA and Temp)

- **DA = PA corrected for non-standard temperature**
- **DA is *equivalent* altitude in the ISA that results in same air density**
- **Air density is the “amount” of air per unit volume**
- **Dense = more air per unit volume**
- **Less dense = less air per unit volume**
- **Air density deceases with altitude:**
  - Lower density occurs at higher altitudes
- **So, high DA means lower air density**

We need to know…DA (or PA and Temp)

- **So, high DA means lower air density, which means:**
  - Lower engine power (normally aspirated)
  - Longer ground tale off roll
    - Need to go faster for the same amount of air to go into the pitot tube to get to V_R
    - Ground speed on take off will be higher than in low DA conditions
  - Lower climb rate
    - Less engine power
    - Less lift at given airspeed (lift equation)
  - Different cruise
    - Low density reduces drag (drag equation)
    - Higher true airspeed, even at lower power
    - Via the wind triangle, higher TAS means faster ground speed, means less fuel
  - Longer ground landing roll
    - Higher TAS = higher GS = “looks faster” (it is!)
    - Fly using the IAS!

Determining DA

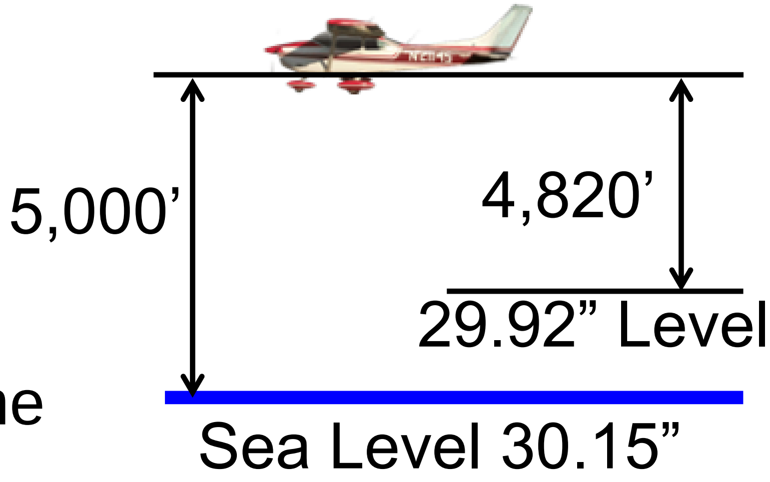
- DA = PA corrected for non-standard temperature
- So, first find PA!

Determining PA - 1

- **Find PA (altitude relative to pressure datum of 29.92”)**
  - Set “the knob” to 29.92”
  - PA = attitude reading
  - PA = 920’ here

Determining PA - 2

- **DA = PA corrected for non-standard temperature**
- **Use the approximate pressure lapse rate of 1,000’ per inch of Hg**



- **Say recorded altimeter setting is 30.1”**
  - This is the pressure at sea level at that place and time
- **You are flying at 5,000’ MSL**
- **PA = 5,000 + (29.92 - 30.1) * 1000 = 4,820’**

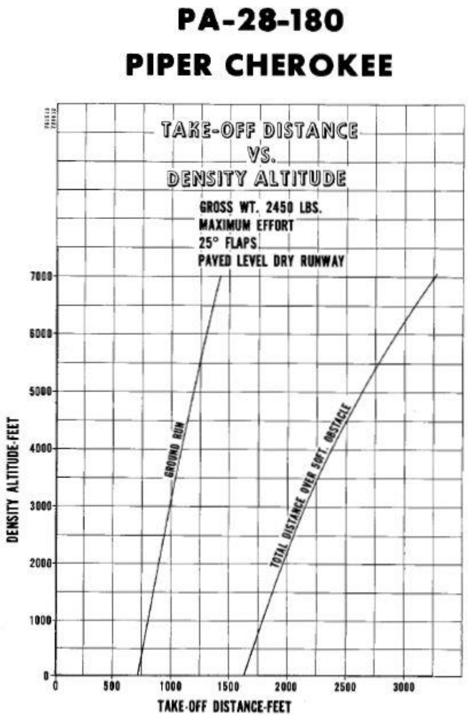
Determining PA - 3

- DA = PA corrected for non-standard temperature
- Use a PA table
- Uses a more accurate lapse rate
- Add the correction factor to the known MSL
- At 5,000’, when reported pressure is 30.1”
- PA = 5,000-165 = 4,835’
- At KFDK, when reported pressure is 28.9”
- PA = 320+975 = 1,295’
- Note that a low ambient pressure increases PA (and so DA)

Altimeter Setting (" Hg)	Pressure Altitude Conversion Factor
28.0	1,824
28.1	1,727
28.2	1,630
28.3	1,533
28.4	1,436
28.5	1,340
28.6	1,244
28.7	1,148
28.8	1,053
28.9	957
29.0	863
29.1	768
29.2	673
29.3	579
29.4	485
29.5	392
29.6	298
29.7	205
29.8	112
29.9	20
29.92	0
30.0	–73
30.1	–165
30.2	–257
30.3	–348
30.4	–440
30.5	–531
30.6	–622
30.7	–712

Either way…

- Some performance graphs require DA
- Some tables need PA and Temp
- Either way, we need to know DA for other things like TAS to CAS conversions
- So…we need to know how to determine DA!



SECTION 5
PERFORMANCE

CESSNA
MODEL 172S

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 Ft: 56 KIAS

Press Alt In Feet	0°C		10°C		20°C		30°C		40°C	
	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst
S. L.	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

NOTES:

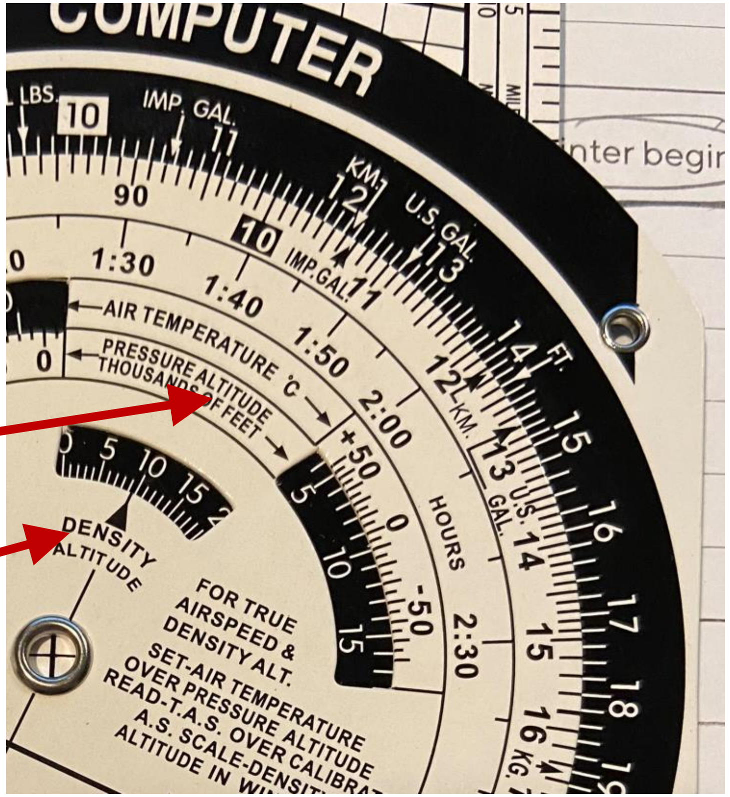
1. Short field technique as specified in Section 4.
2. Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.
3. Decrease distances 10% for each 9 knots headwind. For operation with tail winds up to 10 knots, increase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

Figure 5-5. Short Field Takeoff Distance (Sheet 1 of 3)

Federal Aviation Administration

Determining DA-1

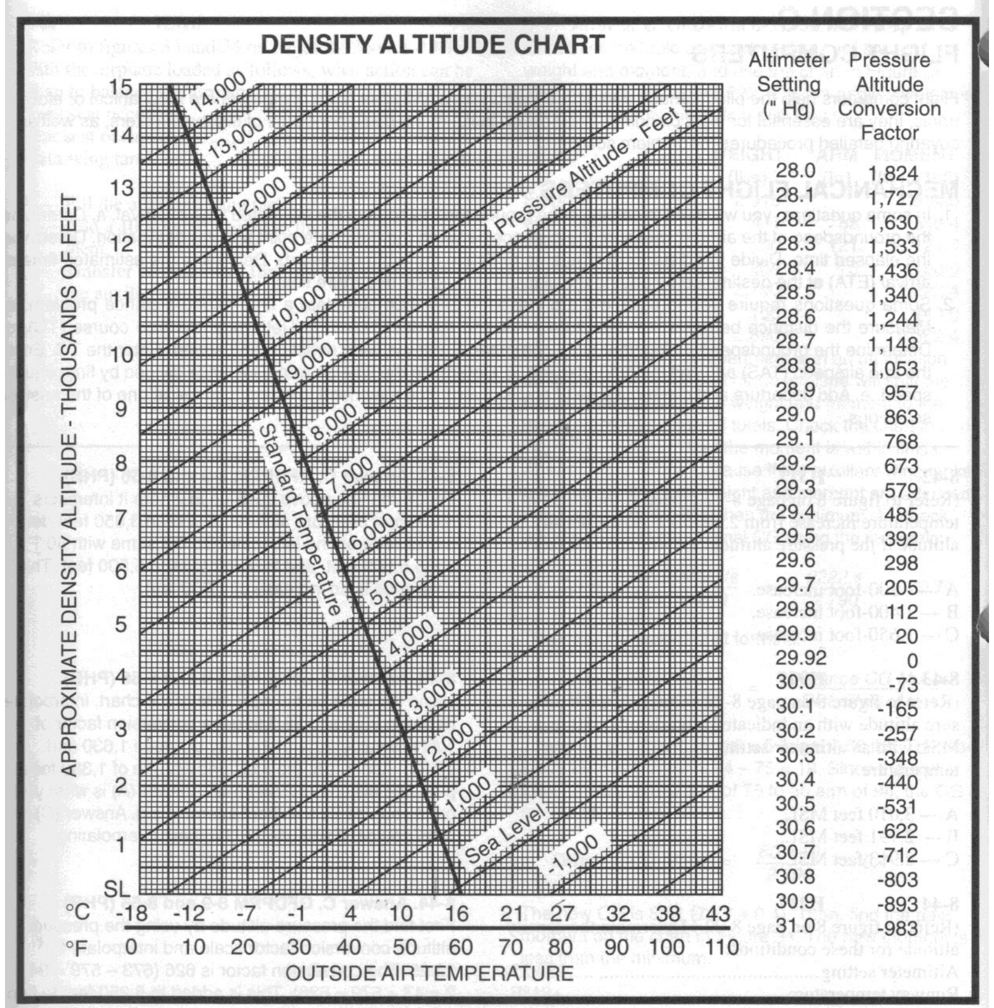
- **E6B** **(or another calculator)**
- **Get PA by setting 29.92" in the altimeter window (set it back after!)**
- **Get outside temperature = Temp**
- **Set PA and Temp on the small right-hand scale. Watch the pos(+) and neg(-) directions!**
- **Read DA**



Determining DA-2a

- **Use the PA-Temp chart**
- **Get PA**
  - Set “the knob” to 29.92” and read-off PA
  - Don’t forget to set it back to QNH

- **Knowing PA and Temp, find DA**



Altimeter Setting (" Hg)	Pressure Altitude Conversion Factor
28.0	1,824
28.1	1,727
28.2	1,630
28.3	1,533
28.4	1,436
28.5	1,340
28.6	1,244
28.7	1,148
28.8	1,053
28.9	957
29.0	863
29.1	768
29.2	673
29.3	579
29.4	485
29.5	392
29.6	298
29.7	205
29.8	112
29.9	20
29.92	0
30.0	-73
30.1	-165
30.2	-257
30.3	-348
30.4	-440
30.5	-531
30.6	-622
30.7	-712
30.8	-803
30.9	-893
31.0	-983

FIGURE 8.—Density Altitude Chart.

Determining DA-2b

- **Use the PA-Temp chart**
- **Get PA**
  - Use QNH (altimeter setting)
  - Determine the PA fiddle factor from the table
  - Add the fiddle factor to elevation or altitude
- **Knowing PA and Temp, find DA**

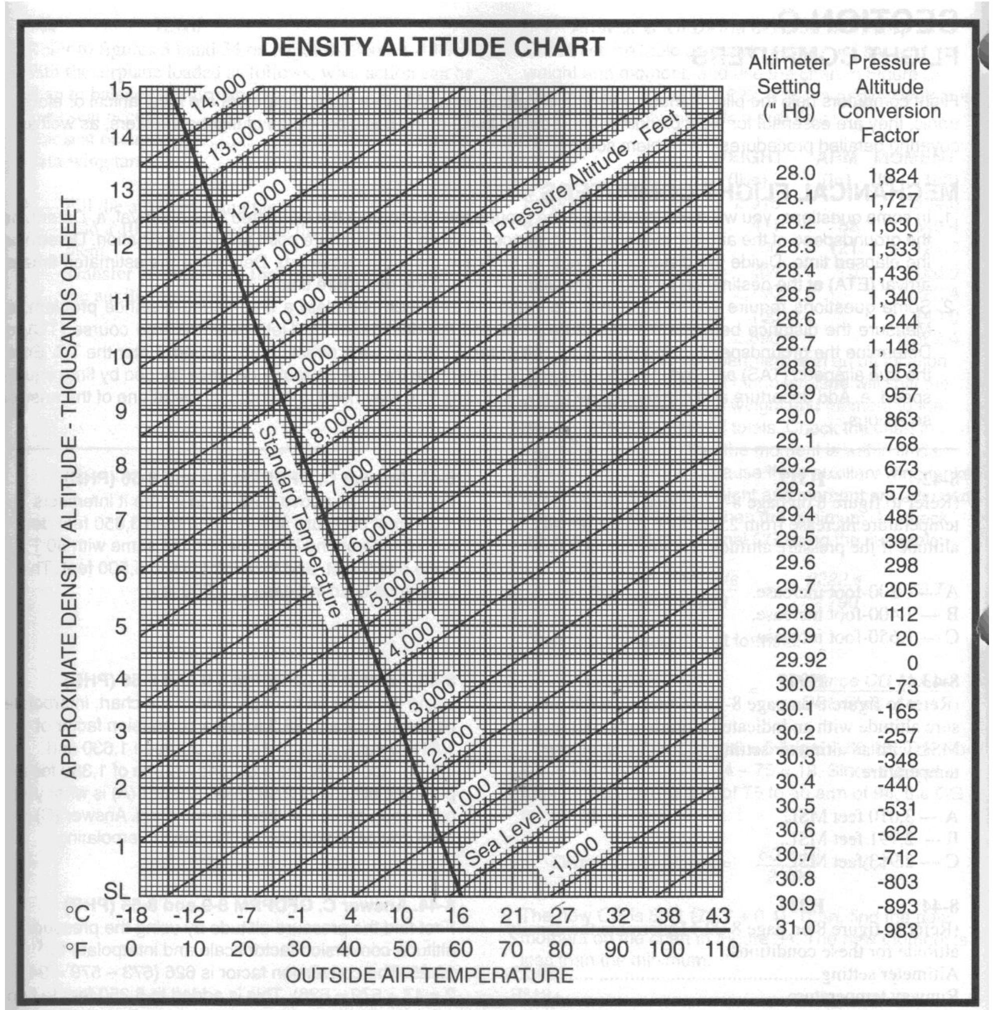


FIGURE 8.—Density Altitude Chart.

Example

- At FDK, elevation = 320’
- If QNH = 29.00”; fiddle factor is +893
- PA = 320 + 893 = 1,313’
- If T = 32°C
- DA = Approx. 3,600’

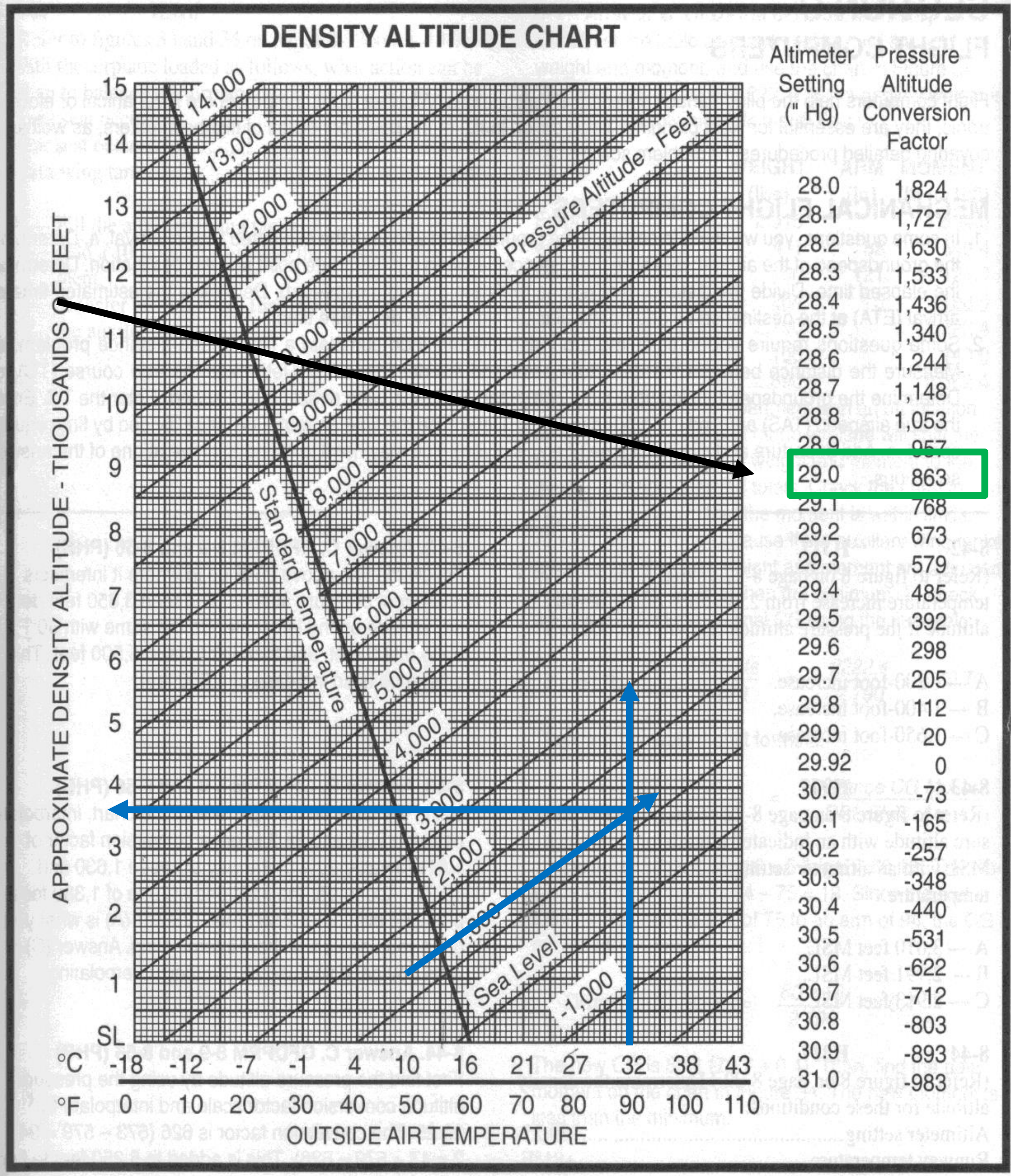
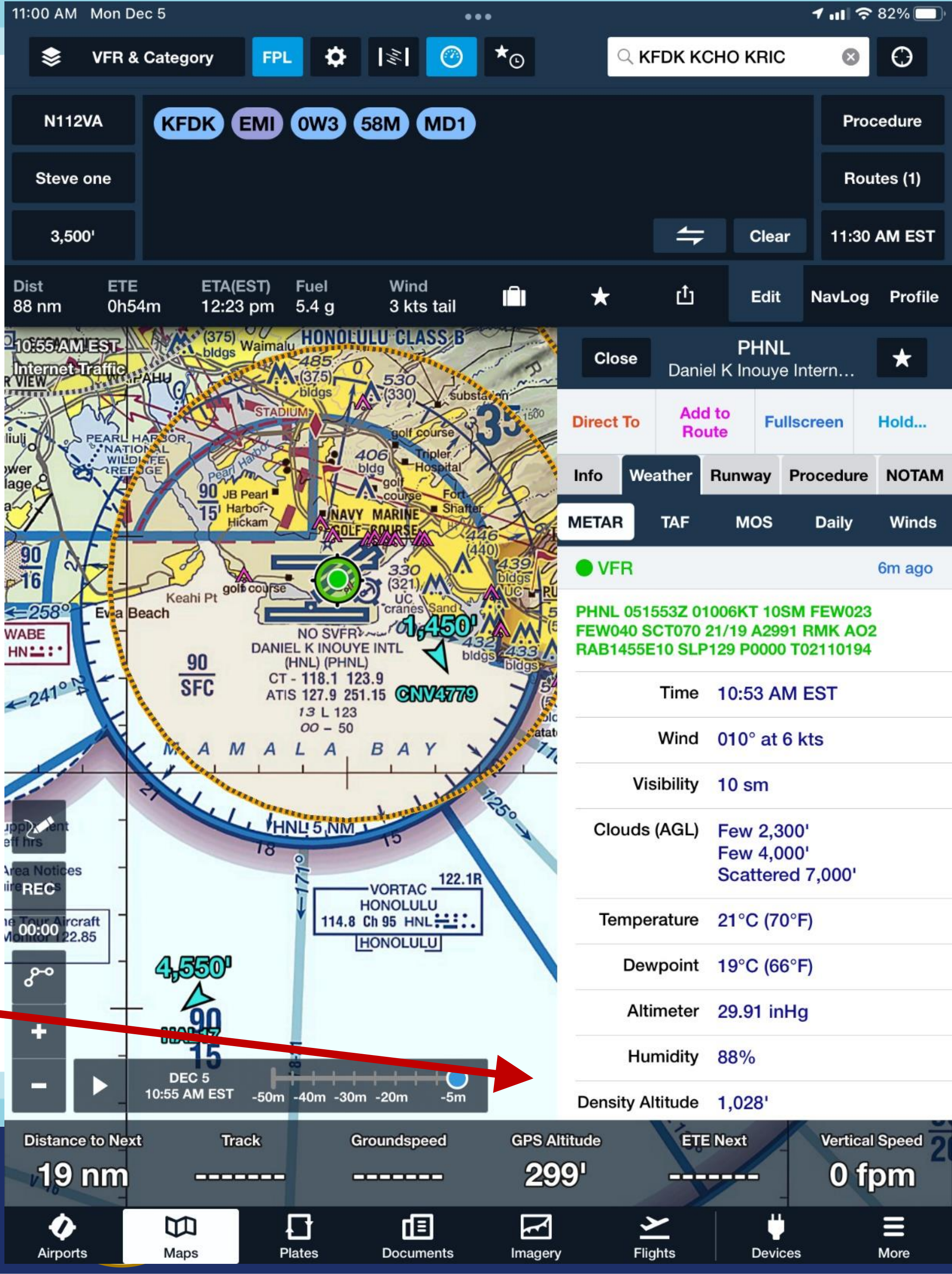


FIGURE 8.—Density Altitude Chart.

Determining DA-3

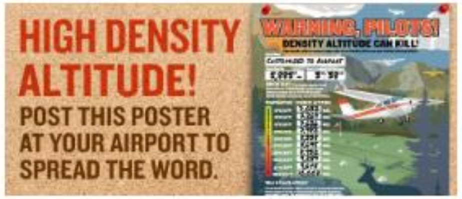
- Listen to the AWOS…!
- Use an online calculator
- Use your fav EFB

- Airport elevation = 13’
- Temp = 21C: DP = 19C
- Alt = 29.91”
- DA = 1,028’



DA Poster from AOPA

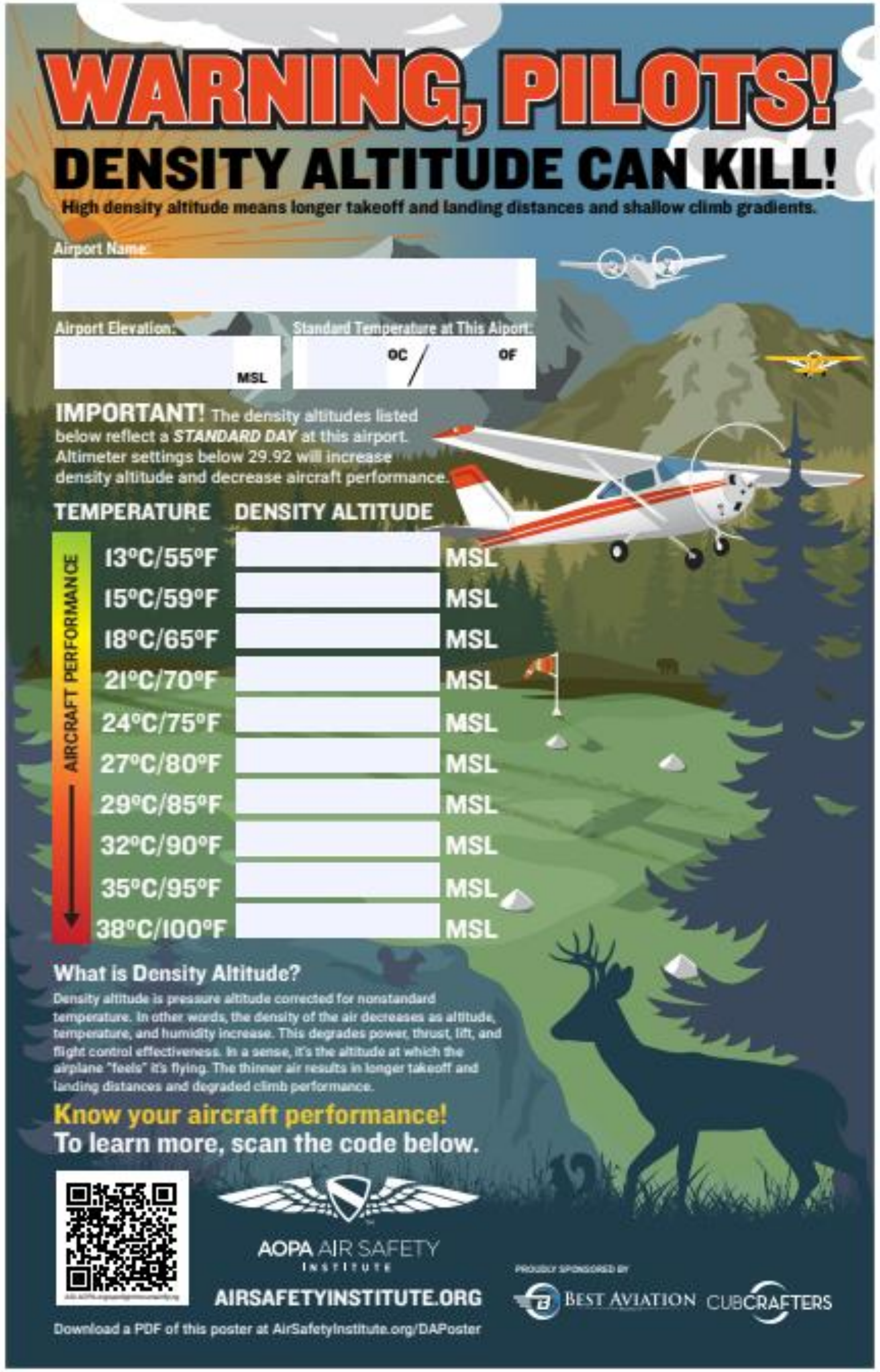
- https://www.aopa.org/training-and-safety/air-safety-institute/safety-publications/density-altitude



Density Altitude: Beware Of Thin Air

High altitude, high temperature, and high humidity create less dense or thinner air that contribute to high density altitude and impact aircraft and engine performance. Modify and use the AOPA Air Safety Institute's Density Altitude Poster to quickly know the density altitude values at your airport on a standard day.

READ THE ARTICLE AND GET THE POSTER



Learning Points

- General aviation accidents continue to be associated with inaccurate or unreasonable expectations with regard to aircraft performance
- Accidents occurring in the takeoff and initial climb phases of flight are likely to be fatal
- Accurate prediction of aircraft performance is essential to dealing with power loss—especially during the takeoff and climb phases of flight
- Running the numbers isn’t that difficult and a “take-off and landing card”, whether manual or electronic, should be part of every pre-flight action plan

Proficiency and Peace of Mind

- **Fly regularly with your CFI**
- **"Revert to training"…only works if…?**
  a) You've seen it before
  b) You've done it recently
- **Practice, practice…**
  – Get in your head
  – …and keep it there…
- **Document in *WINGS***

Next Month's TOM…

The National FAA Safety Team Presents

Federal Aviation Administration

Introduction to Safety Risk Management (SRM)

Presented to: WAFC and Friends
By: Stephen Bateman, CFI
Date: Monday January 9th, 2023

Produced by:
The National FAA Safety Team (FAASTeam)

Thank You For Attending!

You are vital members of our GA safety community!