

III.D. Performance and Limitations

Objectives	The student should develop knowledge of the elements related to airplane performance and limitations as required in the necessary PTS.
Key Elements	<ul style="list-style-type: none">✦ Density✦ Density altitude✦ Airplane performance
Elements	<ul style="list-style-type: none">✦ Determining weight and balance✦ Atmospheric conditions and performance✦ Performance charts✦ Exceeding airplane limitations
Schedule	<ol style="list-style-type: none">1. Discuss objectives2. Review material3. Development4. Conclusion
Equipment	<ul style="list-style-type: none">✦ White board✦ Markers✦ References
Instructor's Actions	<ol style="list-style-type: none">1. Discuss lesson objectives2. Present lecture3. Questions4. Homework
Student's Actions	Participate in discussion Take notes
Completion Standards	The student is able to calculate the airplane's performance based on the current or expected conditions of a flight, and decide whether or not the performance will be sufficient.

References

FAA-H-8083-1, *Weight and Balance Handbook*
FAA-H-8083-25B, *Pilot's Handbook of Aeronautical Knowledge*
(Chapter 11)
POH/AFM

Instructor Notes

Introduction

Overview—review objectives and key ideas.
Why—the use of the operating data for the airplane is mandatory for safe and efficient operations.

Determining W&B

- ✈ CG = total moment divided by total weight
- ✈ Begin with the empty weight.
- ✈ Make a list of everything that will be loaded in the airplane (people, items, fuel, and the weight of everything).
- ✈ Be sure that the loaded weight is within the max weight limits. If the total weight is too high, remove items/people to get within limits.
- ✈ Calculate the moment of each item—use the graph, or multiple the weight by the arm in the POH. Weight/moment of the airplane in its weight and balance documents.
- ✈ Calculate CG.
- ✈ Use the chart to determine if the airplane is within limits.

Atmospheric conditions and performance

Atmospheric pressure—air mass is affected by gravity, and therefore has a force. 14.7 lbs/in under standard conditions at sea level.
Air can be compressed or expanded, changing density.
Density has a significant effect on the airplane's performance.
Increased air density (lower density altitude) increases airplane performance.

Air density factors

- Air density varies:
- ✈ Directly with pressure (pressure goes up, density goes up)
 - ✈ Inversely with temperature (temperature goes up, density goes down)
 - ✈ Inversely with altitude (altitude goes up, density goes down)
 - ✈ Inversely with humidity (humidity goes up, density goes down)

Air density and performance

- As density decreases (air becomes less dense)...
- ✈ power is reduced, as the engine takes in less air. Power produced in proportion to air density.
 - ✈ Thrust is reduced, as the propeller is less effective in thin air. Thrust produced in proportion to the mass of air being accelerated.
 - ✈ Lift is reduced, because the thin air exerts less force on the airfoils.

Leaning

At power settings less than 75%, or at density altitudes higher than 5,000', the engine must be leaned for maximum power on takeoff. An excessively rich mixture will deter engine performance.

High elevation	At higher elevations, high temperatures may have a large effect on density altitude, making safe operations impossible. Even at lower temperatures, excessive humidity may make performance marginal and weight may have to be reduced.
Performance charts	POH Section 5 Used to calculate cruise performance, stall speeds, wind components, takeoff/landing distances, climb performance, true airspeed, endurance/range, based on pressure altitude . The charts don't allow for pilot proficiency or mechanical deterioration. Changes in weather and conditions can result in changes in original calculations. For student pilots, have 100% performance buffer.
Rough approximations	V _A : double the minimum green speed Standard rate turn at given airspeed: remove the last digit from the airspeed and add 5 F to C --- (F-30)/2 C to F - 2 C + 30
Pressure altitude	The height above a standard datum (the theoretical level where the atmosphere is 29.92 "Hg). The altitude indicated when the Kollsman window is set to 29.92. PA at field = 1,000 * (29.92 - KWS) + Elevation
Density altitude	The pressure altitude corrected for non-standard temperature; directly related to aircraft performance. DA = PA + [120 * (Temp - 15 °C)]
Exceeding aircraft limitations	POH Chapter 2 Establish the boundaries for safe operation of the aircraft—exceeding them may have adverse effects Examples: ✦ Attempting takeoff or landing with insufficient runway (may result in collision with obstacle or runway overrun) ✦ Attempting to clear an obstacle that the aircraft performance will not allow at a particular weight (may result in collision with obstacle) ✦ Flying with insufficient fuel to reach airport of intended landing or cruising at a higher power setting (may result in emergency landing) ✦ Using the wrong type of fuel (may result in detonation)

- ✦ Exceeding the structural or aerodynamic limits by being overweight or outside CG limits (may result in aircraft damage or structural failure, may dampen aircraft control, will affect stall speeds)
- ✦ Exceeding maximum crosswind component (may increase landing difficulty, may make runway alignment difficult or impossible, may result in crash)

Conclusion

Brief review of the main points.
Before each flight, ensure the aircraft can produce required performance depending on the airport and atmospheric conditions.

CFI PTS

Objective: To determine that the applicant exhibits instructional knowledge of the elements related to performance and limitations by describing:

1. Determination of weight and balance condition.
2. Use of performance charts, tables, and other data in determining performance in various phases of flight.
3. Effects of exceeding airplane limitations.
4. Effects of atmospheric conditions on performance.
5. Factors to be considered in determining that the required performance is within the airplane's capabilities.
6. Low visibility operations.

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Task	F. Performance and Limitations
References	FAA-H-8083-1, FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating an airplane safely within the parameters of its performance capabilities and limitations.
Knowledge	The applicant demonstrates understanding of:
PA.I.F.K1	Elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance.
PA.I.F.K2	Factors affecting performance, to include:
PA.I.F.K2a	a. Atmospheric conditions
PA.I.F.K2b	b. Pilot technique
PA.I.F.K2c	c. Airplane configuration
PA.I.F.K2d	d. Airport environment
PA.I.F.K2e	e. Loading (e.g., center of gravity)
PA.I.F.K2f	f. Weight and balance
PA.I.F.K3	Aerodynamics.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
PA.I.F.R1	Inaccurate use of manufacturer's performance charts, tables, and data.
PA.I.F.R2	Exceeding airplane limitations.
PA.I.F.R3	Possible differences between calculated performance and actual performance.
Skills	The applicant demonstrates the ability to:
PA.I.F.S1	Compute the weight and balance, correct out-of-center of gravity (CG) loading errors and determine if the weight and balance remains within limits during all phases of flight.
PA.I.F.S2	Demonstrate use of the appropriate airplane manufacturer's approved performance charts, tables, and data.

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Task	F. Performance and Limitations
References	FAA-H-8083-1, FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating an airplane safely within the parameters of its performance capabilities and limitations.
Knowledge	The applicant demonstrates understanding of:
CA.I.F.K1	Elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance.
CA.I.F.K2	Factors affecting performance, to include:
CA.I.F.K2a	a. Atmospheric conditions
CA.I.F.K2b	b. Pilot technique
CA.I.F.K2c	c. Airplane configuration
CA.I.F.K2d	d. Airport environment
CA.I.F.K2e	e. Loading (e.g., center of gravity)
CA.I.F.K2f	f. Weight and balance
CA.I.F.K3	Aerodynamics.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
CA.I.F.R1	Inaccurate use of manufacturer's performance charts, tables, and data.
CA.I.F.R2	Exceeding airplane limitations.
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Skills	The applicant demonstrates the ability to:
CA.I.F.S1	Compute the weight and balance, correct out-of-center of gravity (CG) loading errors and determine if the weight and balance remains within limits during all phases of flight.
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