Chapter 5
Performance

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General

Performance information for the Cessna 172 is contained within this chapter. The information contained within these chapters *must be combined with the information provided in the Performance section of the appropriate aircraft POH* to calculate the necessary performance data for normal operations. It also provides specific performance factors to be considered during abnormal and emergency operations.

Included are representative examples, demonstrating proper use of the charts and / or tables. Both chapters are arranged in the order most typically used by the flight crew (i.e.: preflight, planning, execution, etc.).

Performance information associated with optional systems and equipment is provided in Section 9 (Supplements) of the Pilot's Operating Handbook / Airplane Flight Manual.

The performance information presented in this chapter is based on measured flight test data corrected for I.C.A.O. standard day conditions and analytically expanded for the various parameters of weight, altitude, temperature, etc. Performance charts in the aircraft POH are not factored and do not make any allowance for varying degrees of pilot proficiency or mechanical deterioration of the aircraft.

Preflight Planning

Effects of conditions not considered on the charts must be evaluated by the flight crew, such as the effects of a soft or grass runway surface on takeoff and landing performance, or the effect of winds aloft on cruise and range performance. Endurance can be grossly affected by improper leaning procedures, and in flight fuel flow and quantity checks are recommended.

The information included in this chapter provides the procedures necessary to complete a Bridgewater State College Takeoff Data Card and Flight Plan Form. The performance charts in the aircraft POH include examples to show how to calculate relevant flight information.

Takeoff and Landing Data (TOLD) Card Completion Instructions

This section provides step-by-step instructions for completing the aircraft performance side of the Bridgewater State College Takeoff and Landing Data (TOLD) Card.

NOTE

Altering the date on a previously used TOLD card is unacceptable.
A new TOLD card shall be completed for each aircraft and each flight.

Pilot / Instructor / Date

Enter last name of the Pilot and Instructor, and date of the flight event. Ensure both pilot names (if appropriate) are on the card for non-instructional flights.

ATIS Code

Enter the current ATIS code, if available.

Active Runway

Enter the runway in use as obtained from any valid current report (ATIS, Common Traffic Advisory Frequency (CTAF), UNICOM, Flight Service Station (FSS)).

Winds

Enter current surface winds from any current valid report (ATIS, automated weather reports (ASOS or AWOS), UNICOM, FSS).

Ceiling / Visibility

Enter the ceiling and visibility from any current valid report (ATIS, automated weather reports (ASOS or AWOS), Pilot Report (PIREP), FSS)

Temperature

Enter the surface temperature from any current valid report (ATIS, automated weather reports (ASOS or AWOS), UNICOM, FSS).

Dewpoint

Enter the dewpoint from any current valid report (ATIS report, automated weather reports (ASOS or AWOS), FSS).

Altimeter Setting

Enter the altimeter setting (in inches Hg) from any current valid report (ATIS, automated weather reports (ASOS or AWOS), UNICOM, FSS). If a current local altimeter setting is not available, use departure airport elevation.

Density Altitude
With the values of pressure altitude and surface temperature, calculate and enter density altitude.

NOTE

The following formula may be used to determine density altitude.

PA + 120(CT – ST) = DA

PA – Pressure Altitude
CT – Current Surface Temperature (°C)
ST – Standard Temperature (°C)
DA – Density Altitude

Pressure Altitude
Calculate and enter takeoff pressure altitude.

NOTE

The following two-step formula may be used to determine pressure altitude.

(29.92 – CA) x 1000 = X

X + FE = PA

CA – Current Altimeter Setting
FE – Field Elevation
PA – Pressure Altitude

Runway Length
Enter the lengths, at the departure and arrival airports, of runways of intended use. Obtain this information from the Airport / Facility Directory or other appropriate publication. Ensure that there is sufficient runway available at all airports for the planned flight.

Headwind, Crosswind, and Tailwind Components
It is essential to calculate and enter the headwind, crosswind, and tailwind components to ensure that college, flight crew, and aircraft limitations will not be exceeded. Use the appropriate performance graphs in the Flight Standards Manual.

Aircraft Performance Data

This section of the TOLD Card includes takeoff, runway, cruise, landing information, and V speeds.

Takeoff Distance (and for Short Field Technique)
Insert the takeoff distance calculated by utilizing the Takeoff Distance performance chart in the POH. Calculate for normal and short-field technique. An example of how to perform this calculation is depicted on the chart.

Power Setting (Cruise)
Note the power setting to be used for cruise segments of the flight, as appropriate.

PX Area Transition
Enter the transition cruise airspeed to be used for transiting to and from the practice area.

Fuel Flow (FF)
Enter expected/planned fuel flow based on the expected flight profile.

Runway Condition (Contamination)
Enter the current (departure) runway information. For arrival, enter the expected runway condition. More information on runway contamination is provided later in this chapter.

Landing Distance (and for Short Field Technique)
Insert the landing distance calculated by utilizing the Landing Distance performance chart in the POH. Calculate for normal and short-field technique. An example of how to perform this calculation is depicted on the chart in the POH.

V Speeds

V_{S0} Stalling speed or the minimum steady flight speed in the landing configuration.

V_{S1} Stalling speed or the minimum steady flight speed in a specified configuration.

V_R Rotation speed (varies with the weight of the aircraft).

V_X Best angle of climb airspeed (i.e. the airspeed that delivers the greatest gain in altitude in the shortest possible horizontal distance).

V_Y Best rate of climb airspeed (i.e. the airspeed that delivers the greatest gain in altitude in the shortest possible time).

V_{FE} Maximum flap extended speed (i.e. the highest airspeed permissible with the wing flaps in a prescribed extended position).

V_A Maneuvering speed (i.e. the maximum speed at which application of full available aerodynamic control will not overstress the aircraft). V_A decreases at lighter weights.

V_{NO} Maximum structural cruising speed. Do not exceed this speed except in smooth air, and then only with caution.

V_{NE} Never exceed speed. Do not exceed this speed at any time.

Approach Speed
Speed that must be used for the approach and landing portion of the flight. For instrument approaches both the approach speed and the landing speed must be listed.

Takeoff and Landing Data (TOLD) Card

Student: ______________	**Instructor:** _____________	**Date:** _____________
Aircraft N #__________	**Departure Information**	**Arrival Information**
Winds		
Visibility		
Ceilings (AGL)		
Temperature/Dew Point		
Local Altimeter		
Active Runway(s)		
Density Altitude		
Pressure Altitude		
Runway Length Available		
Headwind Component		
Tailwind Component		
Crosswind Component		
Aircraft Performance Data		
Takeoff Distance (Normal)_______________ Short Field Technique:_____________		
Power Settings (RPM) Cruise:________ PX Area Transition:_______ FF:______		
Runway Condition DRY Contamination: RAIN SNOW ICE		
Landing Distance (Normal):____________ Short Field Technique:_____________		
V_{S1} ___________ V_Y ___________ V_{NE} ___________________________		
V_{SO} ___________ V_{FE} ___________ Approach Speed _______________		
V_G ___________ V_A ___________ Best Glide (Flaps Up) ___________		
V_X ___________ V_{NO} ___________		

Flight Planning Example

Aircraft Loading
Begin by calculating the aircraft weight and center of gravity by utilizing the information provided in Chapter 6 Weight & Balance.

The Basic Empty Weight (BEW) for the aircraft is determined by the manufacturer and entered in the aircraft Pilots Operating Handbook / FAA Approved Airplane Flight Manual. Verify that any alterations to the aircraft that affect the weight and balance have been properly noted in the FAA Approved Airplane Flight Manual, weight and balance record in the aircraft logbook, or the inspection summary in the Bridgewater State College aircraft "can".

NOTE

The inspection summary in the Bridgewater State College aircraft can is NOT the official aircraft weight and balance record. Official weight and balance data can be located in the FAA approved Airplane Flight Manual issued for the specific aircraft.

Determine the actual fuel weight before starting additional weight and balance calculations.

1.	Basic Empty Weight	1615.9 lbs
2.	Occupants (2x170 lbs)	340 lbs
3.	Baggage and Cargo	39.1 lbs
4.	Fuel (6 lbs x 53 gal)	318 lbs
5.	Takeoff Weight	2313 lbs

The TW is below the maximum of 2450 lbs, and the weight and balance calculations have determined the C.G. position within the approved limits.

Takeoff and Landing
After determining the aircraft loading, the pilot must carefully consider and calculate expected takeoff and landing performance. Current and forecast conditions at the departure and destination airport(s) must be evaluated and updated throughout the flight.

Perform landing distance calculations in the same manner using current or forecast conditions at the destination airport. Calculate landing distances only <after> calculating expected landing weight.

Apply the departure airport density altitude conditions and takeoff weight to the appropriate Takeoff Performance and Takeoff Ground Roll graphs in the aircraft POH. This will determine the takeoff ground roll and takeoff ground roll over a 50 ft. barrier. *Use the correct graph line for the appropriate flap setting.* Note that the performance charts depict values for an aircraft at maximum gross weight 2450 lbs, and on a paved level dry runway surface.

Perform the landing distance calculations in the same manner using the existing or forecasted conditions (as appropriate) at the destination airport once the landing weight has been established using the appropriate table(s). Note that the performance charts depict values for an aircraft at maximum gross weight 2450 lbs, and on a paved level dry runway surface. Note also that the Landing Distance chart depicts a landing performed with full flaps.

The conditions for the example flight are listed below.

	Departure Airport	**Destination Airport**
1. Pressure Altitude	1500 ft	2000 ft
2. Temperature	28^{o}C	25^{o}C
3. Wind component	12 KTS (Headwind)	4 KTS (Head)
4. Runway Length Available	3500 ft.	3000 ft.
5. Ground Run or Roll (approx.)	1075 ft.	565 ft.
6. Runway required (approx.)	1109' Ground roll	1290 ft.
7. Distance to clear 50' Obstacle	1992'	

NOTE

The remaining performance charts in this example assume zero winds. Winds aloft must be considered when computing climb, cruise and descent performance.

Climb

Use POH values for the desired cruise pressure altitude and corresponding cruise outside air temperature to determine climb performance (time, distance, fuel burn), then apply the existing conditions at the departure field to the graph. Subtract these values from those for the cruise pressure altitude. The results provide true fuel, time and distance components for the climb segment of the flight corrected for field altitude and temperature.

These example numbers are calculated using the above instructions and the appropriate graph.

1. Cruise Pressure Altitude	5500 ft
2. Cruise OAT	20^{o}C
3. Fuel to Climb	1.5 gal
4. Time to Climb	Approx. 6 min
5. Distance to Climb	Approx. 8 NM

Descent

Descent planning is often overlooked in localized training operations, but it must be calculated prior to determining cruise flight total distance for extended flights. Use the cruise pressure altitude and the OAT to determine basic fuel, time, and distance for descent. Adjust by subtracting the field pressure altitude at the destination airport to give the actual fuel, time, and distance for the descent to field elevation.

1.	Descent Profile	700 fpm
2.	Altitude Change	4500’
3.	Descent Time	6.5 min.
4.	Descent Speed	109 TAS
5.	Winds During Descent	10 Knts (Hdwd)
6.	Descent Fuel Consumption	1.0 GPH
7.	Total Distance	9.1 NM

Cruise

Use total flight distance, subtract the previously calculated distances to climb and descend. The remaining figure is total cruise flight distance.

Calculate cruise performance using true airspeed. Calculate TAS by selecting a cruise power setting and referring to the pressure altitude and temperature values.

Divide cruise distance by the cruise speed to determine cruise flight time. Calculate fuel consumption during cruise flight by multiplying the cruise fuel flow by the cruise flight time.

The following figures are used for the flight planning example.

8.	Total Distance	320 NM
9.	Cruise Power (Economy)	65% power
10.	Cruise Speed	109 TAS
11.	Winds at Altitude	10 Knts (Hdwd)
12.	Cruise Fuel Consumption	8.0 GPH
13.	Cruise Time	3.2 hours
14.	Cruise Fuel	25.6 gallons

Total Flight Time

Determine total flight time by finding the sum of time to climb, time to descend and cruise flight time. Remember to convert time in minutes to time in hours for all calculations.

1.	Total Flight Time	3.5 hours

Total Fuel Required
Determine total fuel required (gallons) by adding fuel to climb (including run up and taxi), cruise fuel, and fuel to descend. Multiply this value by 6 lbs/gal, for total fuel weight used for flight.

The following total fuel calculation is used for the flight planning example.

1.	Total fuel required	28.0 gal
2.	Total weight of required fuel	168.0 lbs

Flight Planning Considerations

Contaminated Runway Environment
A contaminated runway can occur in any climate, and pilots must understand the potential effects on aircraft performance. Information provided below is referenced from AC 91-79 Runway Overrun Prevention (11/6/2007).

Standing Water
Standing water is usually the result of heavy rainfall and/or insufficient drainage. A runway is considered contaminated by standing water when more than 25% of the runway surface area (whether in isolated areas or not), within the required length and width being used, is covered by 1/8 inch or more of standing water.

Slush
Slush is snow saturated with water that displaces with a splatter when pressed upon. It is normally encountered at temperatures above freezing and at or below 5°C (41°F). A runway is considered contaminated with slush when more than 25% of the runway surface area (whether in isolated areas or not), within the required length and width being used, is covered by 1/8 inch or more of slush.

Wet Snow
Wet snow will easily stick together and tend to form a snowball if compacted by hand. A runway is considered contaminated with wet snow when more than 25% of the runway surface area (whether in isolated areas or not), within the required length and width being used, is covered by 1/4 inch or more of wet snow.

Dry Snow
Dry light snow is loose and can easily be blown. If compacted by hand, it will readily fall apart. A runway is considered to be contaminated with dry snow when more than 25% of the runway surface area (whether in isolated areas or not), within the required length and width being used, is covered by the equivalent of more than 1/8 inch of dry snow.

CAUTION

Performance charts do not factor effects of contaminated runways or precipitation drag. Flight crews must carefully evaluate any expected impact on aircraft performance.