Objectives	▪ The student should develop a knowledge of the elements related to performance and limitations for multiengine aircraft
Elements	▪ Determining Weight and Balance ▪ Atmospheric Conditions and Performance ▪ Performance Charts ▪ Multiengine Specific Performance ▪ Determine if required Performance is Attainable ▪ Exceeding Aircraft Limitations
Schedule	▪ Discuss objective ▪ Review Material ▪ Development ▪ Conclusion & Review
Equipment	▪ White Board / Markers ▪ References
CFI Actions	▪ Present lesson ▪ Use teaching aids ▪ Ask/ answer questions
Student Actions	▪ Participate in discussion ▪ Take notes ▪ Ask / answer questions
Completion Standards	▪ The student has the ability to calculate the required performance for their specific aircraft and decide if these calculations meet requirements

Additional Notes: ____
____
____
____

<u>CE</u> = **Common Error**

Introduction

Overview

Review objectives / Elements

What

The performance and limitations section of the POH contains the operating data for a specific airplane. This data includes charts for determining takeoff, landing, cruise, etc. performance.

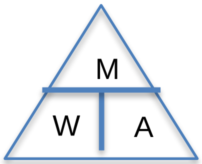
Why

It is important to know what performance we are likely to obtain before a flight as well as abiding by the limitations set in section 2 of the POH

How

Determining Weight and Balance

See Weight & Balance lesson plan in initial CFI lesson plans for the in-depth lesson



- **Basic process of finding weight and balance via the computational method**
  - CG(Arm) = Moment/Weight
- **Begin with the basic empty weight and find the weights of every item to be loaded into the plane**
  - Be sure this weight is within the max ramp weight limitation of the AFM
  - If the weight is too high, remove items or fuel to bring it within limits
- **Calculate the moments of all the items**
  - Refer to the poh for the respected arm of each station and multiply that by the weight of items occupying the station
  - Add the moments together to get the total moment
- **Find the CG by doing total moment / total weight**
  - Use the CG envelope graph to ensure the CG is within operational limits.
- **Weight shift can be done using the following formula** $\frac{\boldsymbol{weight\ to\ be\ shifted}}{\boldsymbol{Total\ weight}} = \frac{\boldsymbol{Change\ in\ CG}}{\boldsymbol{distance\ weight\ is\ shifted}}$

Atmospheric Conditions and Performance

Density Altitude

- **Density altitude is the pressure altitude corrected for non-standard pressure**
  - Pressure altitude is altitude corrected of nonstandard pressure
- **Barometric pressure, Temperature, altitude, and humidity all affect air density**
- **As air becomes less dense density altitude increases and aircraft performance drops**

- **Aircraft performance drops at lower air density mainly due to:**
  - Less air molecules for combustion
  - Less air molecules for the prop to generate lift with
  - Less air molecules for the wings to create lift with
- **Always be aware of the density altitude as there may be scenarios where high-density altitudes can pose a risk to flight**

Performance Charts

- **Airplane performance charts are found in section 5 of the POH/AFM**
- **Using the performance charts, we can calculate**
  - Takeoff distance (over 50' obstacle as well)
  - Time, fuel & distance to climb
  - Climb rate chart
    - We use this to find absolute ceiling and service ceiling
    - 2 engine absolute ceiling – altitude at which no climb can be established with 2 engines at full power
    - 2 engine service ceiling – altitude at which 100fpm can be maintained with 2 engines at full power
  - Cruise performance
  - Endurance
  - Landing Distance (over 50' obstacle as well)
  - Crosswind component
  - IAS -> CAS conversion
  - Stall speed in certain configurations
- **All these charts use Pressure altitude**
  - To find PA the equation is $Pa = (29.92 - Alt.Setting) * 1000 + field\ elevation$
  - To find DA (not needed for most charts) $Da = Pa + (120(temp - STDTemp))$
- ***Demonstrate using performance charts to student***

Multi Engine Specific Performance

- **Multiengine aircraft have specific charts and performance concepts**
- **Performance charts for ME aircraft include**
  - Accelerate-Stop distance – distance to accelerate to V_R or V_{LOF} (whichever is specified by manufacturer), Experience engine failure, abort takeoff and stop
  - Accelerate-Go distance – Distance required to accelerate to V_R, experience an engine failure, commit to takeoff and clear a 50' obstacle
    - Data from these charts are unlikely to be duplicated due to how specific they are
  - Single Engine climb performance – Climb rate that is possible with OEI
    - This chart allows us to find Single engine service and absolute ceiling
    - Single engine absolute ceiling – altitude at which no climb can be maintained with OEI (you will drift down to this)

        - Single engine service ceiling – altitude at which a climb of 50FPM can be maintained with OEI
- **Careful consideration should be made to the SE absolute ceiling and service ceiling during flight planning**
    - When encountering an engine failure with negative SE climb performance, the airplane cannot fly on one engine.
    - Light twins under 6000lbs don't have to abide by any single engine performance minimums
        - Performance just needs to be calculated however, PIC decision dictates flight
    - More than 6,000 pounds maximum certificated takeoff weight and/or V_{SO} of more than 61 knots
        - The single-engine rate of climb in feet per minute at 5,000 mean sea level (MSL) must be equal to at least .027 V_{SO} squared. For twins type-certificated on or after February 4, 1991, the single-engine climb requirement is expressed in terms of a climb gradient, 1.5 percent.
- *Calculate performance with student for today's flight*

Determining the Required Performance is Attainable

- After the performance data is calculated using the performance charts, apply it to the surroundings
    - Compare TO/L distances to runway lengths etc.
- Know that performance is very dependent on whether, understand that later on in the day the performance can be greatly different due to this
    - Plan ahead

Exceeding Airplane Limitations

- The POH section 2 outlines operational limitations for the aircraft
- These limitations are put in place to ensure safe operation of the aircraft
- Adverse effects of exceeding these limitations can include
    - Not having enough runway distance to take off and land
    - Not having enough fuel to reach the destination
    - Exceeding the airframes load limits may cause catastrophic damage to the aircraft
    - Exceeding max demonstrated crosswind isn't necessarily dangerous however, it can make for a very challenging takeoff/landing

Conclusion & Review

Review

- Briefly review the key points
- Stress the importance of completing these performance calculations before every flight