Flight Advisor Corner by Hobie Tomlinson

November 2012 **Flying Multi-Engine Aircraft (Pt. VI)**

Progressing on with our series on flying FAR Part 23 (CFR 14, Chapter 1, Subchapter C, and Part 23) certified, small multi-engine airplanes, we continue looking at the issues involved in a multi-engine transition course. This month we will be continuing our look at a typical General Aviation Manufactures Association (GAMA) standard format Airplane Flight Manual (AFM) issued for FAR Part 23 certificated airplanes.

"Smallest of the Small"– AMEL Airplanes

2 Place, 1967 Wing D-1 Derringer (S/N 3) @ "Sun-N-Fun," Lakeland, FL in 2009

Two 160 hp Lyc. Engines, MGW = 3050 Lbs., 212 MPH Cruise, 12 were built **Wikipedia Image**

Last month we stopped after discussing the issues of Checklists, Flight Profiles, and the effect of Light Vs Heavy operating weights on Controllability and Performance. We will pick up where we left off by continuing with Section III.

Section III (Emergency Procedures) section of the AFM contains both Emergency Procedures and what would better be defined as Abnormal Procedures, as we have previously discussed. It is also not uncommon to find supplemental instructional information, which is intended to help transitioning pilots understand a procedure, although it clearly is not a direct part of the procedure. This supplemental information may involve Caution or Warning information, a recommended technique, or just be instructional in nature. The Emergency Procedures also include Checklist items which clearly need to be memorized, although they are not noted as such in many of the older AFMs. Newer AFMs typically enclose such checklist items within a "box" on the checklist, hence the generic term "Boxed Items." (I'm still a big fan of creating and using Flash Cards for the purpose of memorizing and periodically reviewing critical memory items on the aircraft that I fly.)

Airspeeds needed for aircraft operation are sometimes frustratingly hard to find. On aircraft certified prior to the introduction of FAR Part 23 Airplane Flight Manuals (**AFMs**) in 1978, (i.e. CAR Part 3 aircraft certified prior to February 1, 1965 and FAR Part 23 aircraft certified after that date) the information has to be tracked down from the Aircraft Type Data Sheets, Owner's Manuals and Aircraft Placards. The Airplane Type Data Sheet and Placards will contain a list of limiting airspeeds. Other recommended airspeeds for normal operation need to be found in the owner's manuals or other furnished technical information.

The Introduction of AFMs in 1978 made the process a lot simpler; however, it still takes a little effort to compile a comprehensive list of airspeeds used during flight operations. These airspeeds are listed in the following three places in the AFM:

1) **Section II (**Limitations) lists Limiting Airspeeds on the first page. These are the same airspeeds that will be found listed in the Airplane's Type Data Sheet.

2) **Section III** (Emergency Procedures) lists Emergency Airspeeds on the first page. These are the airspeeds which are required for Engine Inoperative (**EI**) operations and any other Emergency Procedures (i.e. Emergency Descent).

3) **Section IV** (Normal Procedures) lists Safe Operating Airspeeds on the first page. These are the airspeeds that are to be used during various Normal and Abnormal Flight Procedures. They include both airspeeds for Two Engine and Engine Inoperative conditions. There are some repetitions of certain airspeeds, but all three locations must be referred to in order to develop a comprehensive list of reference airspeeds. Some of these are marked on the airspeed indictor, some are located on placards in the airplane, and the remaining ones just need to be known. Airspeeds presented are always for Maximum Gross Weight (**MGW)** unless specified otherwise.

The Next Step in the Emergency Procedures section of the AFM (Section III) is to sort out the following items imbedded in Section III. (**Note:** The following list is from a Beechcraft Baron 58 AFM.)

- **Emergency Airspeeds** – (Require Memorization)

- **Emergency Checklists –** (Require Immediate Action)
    - Take-off Engine Failure Before Lift-off
    - Take-off Engine Failure After Lift-off
    - Engine Fire On-the-Ground
    - Engine Fire In-Flight
    - Emergency Descent
    - Dual Engine Failure (Glide)
    - Engine Inoperative Go-Around

Hobietw@att.net (802) 363-3411

- Electrical Smoke or Fire
- Unscheduled (Uncommanded) Electric Trim

- **Emergency Checklist Steps which Require Memorization – (**Boxed Items)
  - Steps 1 – 2 of Engine Failure Before Lift-off
  - Steps 1 – 5 of Engine Failure After Lift-off
  - Steps 1 – 5 of Engine Fire On-the-Ground
  - Steps 1 – 4 of Engine Fire In-Flight
  - Steps 1 – 5 of Emergency Descent
  - Steps 1 – 3 of Dual Engine Failure
  - Steps 1 – 4 of Engine Inoperative Go-Around
  - Steps 1 – 4 of Electrical Smoke or Fire
  - Steps 1 – 4 of Unscheduled Electric Trim

- **Abnormal Checklists –** (Not Time Critical)
  - Airborne Engine Start
  - Gear-Up Landing (Intentional)
  - Engine Inoperative (EI) Approach & Landing
  - Engine Inoperative Fuel Crossfeed
  - Alternator Warning Light(s) Illuminated
  - Landing Gear Manual Extension
  - Landing Gear Retraction after a Practice Manual Extension
  - Surface De-ice System Failure
  - Propeller De-ice System Procedures
  - Alternate Static Air Procedures

- **Supplemental Information –** (Additional Information which is **not part** of a Checklist)
  - One Engine Operation Considerations
  - Determining Inoperative Engine
  - Engine Inoperative Go-Around Performance Warning
  - Engine Inoperative Fuel Crossfeed Warning
  - Electrical Smoke or Fire Warning
  - Landing Gear Manual Extension Warning
  - Emergency Exit Use
  - Unlatched (Open) Main Cabin Door In-Flight Considerations
  - Simulation of One Engine Inoperative (**Note:** Important Flight Training Information for use by Multi-Engine Instructors)
  - Inadvertent Spin Information (**Note:** Very Important Flight Training Information for use by Multi-Engine Instructors)

Section IV (Normal Procedures) section of the AFM contains Normal Procedures plus additional Selected Supplemental Procedures.

- **Airspeeds for Safe Operation – (**Based on Operation at MGW)

- **Normal Procedures Checklists**
  - Preflight
  - Before Start
  - Starting
  - After Start
  - Before Takeoff
  - Takeoff
  - Maximum Performance Climb
  - Cruise Climb
  - Cruise
    - Maximum Power Cruise
    - Normal Cruise
    - Economy Cruise
  - Descent
  - Before Landing
  - Balked Landing (Go-Around from flight-idle power in full landing configuration that is commenced below 50 feet AGL)
  - After Landing
  - Shutdown & Securing

- **Supplemental Information**
  - Warning against Taxiing with a Flat (Landing Gear) Shock Strut
  - Warning about Starting with External Power
  - Caution about Starter – Failure to Disengage
  - Caution about maximum RPM with low Engine Oil Temperature
  - Caution about Propeller Feather-Check Technique
  - Note About Climb during High Ambient Temperatures
  - Proper Engine Leaning Techniques
  - Recommended Descent Airspeeds
  - Note about Installing Engine Air Scoop Covers
  - Oxygen System Procedures
  - Electric Elevator Trim Check
  - Cold Weather Operations
  - External Power Procedures
  - Ice Protection System Checks
    - Alternate Static Air
    - Surface De-ice System (De-ice Boots)
    - Propeller De-ice system (Electric)
    - Windshield De-ice System (Alcohol)
    - Pitot Heat and Heated Stall Warning
  - Practice Vmca Demonstration Procedures (**Note:** Very Important Flight Training Information for use by Multi-Engine Instructors)

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Section V (Performance) Section of the AFM provides the performance data which was derived by the airplane manufacturer during the airplane's certification flight tests.

- **Introduction to Planning and Performance** – (General Information and Sample Problems)

- **Comments Pertinent to Use of Performance Graphs** – (Reference Notes)

- **Performance Graphs**
  - Airspeed Calibration – Normal System
  - Altitude Correction – Normal System

  - Airspeed Calibration – Alternate System
  - Altitude Correction – Alternate System

  - Fahrenheit to Celsius Conversion
  - International Standard Atmosphere (**ISA**) Conversion

  - Manifold Pressure vs. RPM – Non-Recommended Power Settings to limit Brake Mean Effective (Cylinder) Pressures (**BMEP**).

  - Weights Allowing Positive Engine Inoperative Takeoff Climb – With Landing Gear Down (**Note:** Positive EI Gear Down climb performance is a required component for "Accelerate-Go" capability)

  - Stall Speeds at Idle Power

  - Wind Components – Demonstrated Crosswind Component

  - Take-Off Distance
    - It is very important to read and apply all Associated Conditions on the chart in order to achieve the charted performance.
    - Only 50 percent of actual headwind component should be used for computations.
    - Take-off should not be attempted when ground roll exceeds 85 percent of the runway surface available.
    - Charts are always based upon using a **static power takeoff** (i.e. full takeoff power is obtained prior to brake release). When using a "rolling takeoff" (i.e. takeoff power is set during the takeoff roll) always add 500 feet to the charted distances.
    - It is permissible to consider clearway distance (area between the end of the runway surface and the first obstacle) when computing takeoff distance to 50 feet AGL.
    - When excess runway surface is available, liftoff speed should be increased by 10 Kts – This is called a "Thrust Bump" procedure that uses increased runway takeoff distance to improve second segment climb performance, typically the weakest area of twin engine airplane performance.

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- Accelerate-Stop Distance
  - It is very important to read and apply all Associated Conditions on the Chart in order to achieve the charted performance.
  - This distance will always be longer than the two-engine take-off distance
  - Only 50 percent of actual headwind component should be used for computations.
  - Charts are always based upon using a **static power takeoff** (i.e. full takeoff power is obtained prior to brake release). When using a "rolling takeoff" (i.e. takeoff power is set during the takeoff roll) always add 500 feet to the charted distances.
  - The distance will increase when using the "Thrust Bump Procedure.
  - For maximum safety, runways which do not provide adequate accelerate stop distance should be avoided.

- Accelerate-Go Distance
  - It is very important to read and apply all Associated Conditions on the chart in order to achieve the charted performance – this chart assumes an engine failure at lift-off with the propeller feathered immediately (**Note:** A windmilling propeller is always the highest drag item and typically equals the drag experienced in full landing configuration – gear down and landing flaps)
  - Only 50 percent of actual headwind component should be used for computations.
  - Charts are always based upon using a **static power takeoff** (i.e. full takeoff power is obtained prior to brake release). When using a "rolling takeoff" (i.e. takeoff power is set during the takeoff roll) always add 500 feet to the charted distances.
  - This is a maneuver that most piston twins cannot accomplish, although it is possible in the BE-58 at light weights and very low density altitudes.
  - It is very important to know when the aircraft you are flying cannot accomplish this maneuver and make your takeoff contingency plans accordingly.
  - The minimum runway length for maximum safety is the greatest of the following:
    - 115 percent of the Two Engine Takeoff distance
    - Accelerate-Stop distance
    - Accelerate-Go distance.

- Climb – Two Engine
  - It is very important to read and apply all Associated Conditions on the chart in order to achieve the charted performance.
  - It is important to insure that you can meet the required climb gradient when higher-than-standard climb gradient obstacle clearance departures are made under IMC.

- Takeoff Climb Gradient – Engine Inoperative
  - It is very important to read and apply all Associated Conditions on the chart in order to achieve the charted performance.
  - It is also very important to note when the airplane cannot maintain a 3.3 percent climb gradient (200 feet per NM) with an engine inoperative. This is the minimum climb gradient required to insure terrain clearance on a standard obstacle clearance departure procedure under Instrument Meteorological Conditions – **IMC**. If this is not possible, an alternate escape route needs to be planned in case of an engine failure. Very few piston twins can maintain the minimum required IMC climb gradient of 3.3 percent with an engine inoperative.

- Time, Fuel, and Distance to Climb
  - It is important to read and apply all Associated Conditions on the chart in order to achieve the charted performance.

- Climb – Engine Inoperative
  - It is important to read and apply all Associated Conditions on the chart in order to achieve the charted performance.
  - It is very important to know at what density altitude Engine Inoperative Climb is not possible, especially when operating in the western US. When Engine Inoperative Climb is not possible, an emergency off-field landing must be immediately planned in the event of a very low altitude engine failure during the second segment climb. (In the BE-58 at MGW this starts to happen above 6000 ft. pressure altitudes.)

- Service Ceiling – Engine Inoperative
  - It is important to read and apply all Associated Conditions on the chart in order to achieve the charted performance.
  - For maximum safety when operating IMC over terrain, which is higher than the Engine Inoperative Service Ceiling, it is important to plan a route which keeps suitable "drift-down" emergency airports always within reach. (For the BE-58 at MGW, this would include all Minimum Enroute Altitudes (MEAs) above 6,000 feet MSL.

- Cruise Speeds
  - Best cruise speed for all normally aspirated, piston engine airplanes is obtained at the altitude where the desired cruise power setting is at full throttle.
  - Best cruise speed for all turbocharged piston, turboprop and turbojet airplanes is obtained at the highest altitude at which the engines can produce the desired cruise power setting (**Note:** The

maximum altitude at which a turbocharged piston engine can produce full rated takeoff power is defined as its "Critical Altitude".)

    - The optimum cruise altitude is 100 times the enroute distance, up to the airplanes best cruise altitude. (i.e. It would be 60 x 100 or 6,000 feet for a 60 nm enroute distance.)
    - The BE-58 achieves this for Normal Cruise power at approximately 6,000 feet MSL.

- Fuel flow vs. Brake Horsepower
- Cruise Power Setting Charts
- Range and Endurance Profile Charts
- Holding Time Chart
- Time, Fuel, and Distance to Descend.
    - The chart uses a "constant airspeed" descent (Reduced Power) at 500 FPM to produce best economy.
    - Using a "constant power" descent (High Airspeed) will produce minimum time.
    - A Descent Distance of three times the altitude to descend will give a 3 percent descent gradient and is flown with a descent rate of 5 times your groundspeed. For example, to descend 6,000, feet start down 18 miles from your desired level-off point (6,000' x 3) and use a descent rate of 900 fpm at 180 Kts Ground Speed (180 Kts x 5). This is the normal descent procedure which is typically used.
    - A Descent Distance of six times the altitude to descend will give a 1.5 percent descent gradient and is flown with a descent rate of 2.5 times your groundspeed. For example, to descend 6,000 feet, start down 36 miles from your desired level-off point (6,000' x 6) and use a descent rate of 450 fpm at 180 Kts Ground Speed (180 Kts x 2.5). This is an alternate descent procedure which is often used for passenger comfort in unpressurized airplanes.
- Balked Landing Climb
    - Two Engine Climb Performance in the Landing Configuration (Gear Down and Landing flaps). This chart confirms that the airplane has Go-Around performance capability under the charted conditions.
- Landing Distance
    - It is important to read and apply all Associated Conditions on the chart in order to achieve the charted performance. (The BE-58 Landing Distance chart only gives "Minimum Distance" – I. e. Short Field landing distances.)
        - The charted approach speed must be maintained.
        - The BE-58 chart requires a descent rate of 800 FPM on final approach.

  - The runway surface must be paved, level and dry.
  - Maximum braking must be used.
- Normal Landings should not be attempted on runways which do not allow for landing and stopping within 67 percent of the available runway surface distance. Contaminated runways should never be used if they are shorter than this length.
- Short Field Landings should not be attempted on runways which do not allow for landing and stopping within 80 percent of the available runway surface distance. These runways must be "uncontaminated" to be considered as suitable for use.
- Adequate Takeoff distance will almost always be the limiting factor in determining the minimum suitable runway length. (Landing Distances will almost always be shorter than the takeoff distances.)

This looks like a good place to break for this month. Next month we will pick up our discussion with Section VI (Weight and Balance and Equipment List).

The thought for this month is ***"The highest reward for a person's toil is not what they get for it, but what they become by it."* ~ John Ruskin, British art critic.**

So until next month, be sure to **"Think Right to FliRite!"**

"Largest of the Large"– AMEL Airplanes

Air Canada B777-300ER @ $315 Million USD – (Currently 1030 B777s built)

Twin GE Engines @ 115,540 lbf ea. / MGW: 775,000 lbs. / Range 7930NM – Wikipedia Image