Flight Advisor Corner by Hobie Tomlinson

June 2012 **Flying Multi-Engine Airplanes, Pt. I**

I have thought about doing a series on flying Multi-Engine airplanes for some time, but I have deferred it due to the fact that small, piston powered multi-engine airplanes are not in as widespread use as they were during General Aviation's heyday of the late '60s and early '70s. That being said, due to the price collapse in these types of airplanes, another group of owners are starting to consider them. Thus, I thought it probably a good time to go back and look at some of the issues involved in flying these aircraft.

Because Multi-Engine aircraft encompass such a diversity of airplanes; we first need to define which specific airplanes we are addressing, even though the generic principles of operation apply to all multi-engine airplanes. In these articles, we will be specifically addressing small, multi-engine airplanes of 12,500 pounds or less **M**aximum **T**ake**o**ff **W**eight **(MTOW)** certified under CFR 14, Chapter 1, Subchapter C, and Part 23.

Code of Federal Regulations (CFR) Title 14, (Aeronautics and Space), Chapter 1 (Federal Aviation Administration), Subchapter C (Aircraft), **Part 23** (Airworthiness Standards) covers the design and certification of Normal, Utility, Aerobatic, and Commuter category airplanes of 12,500 pounds MTOW or less. In contrast, CFR 14, Chapter 1, Subchapter C, **Part 25** covers the design and certification of Transport category airplanes of over 12,500 pounds MTOW.

Small, Multi-Engine Airplanes certified under Part 23 do not have the engine inoperative performance guarantees that Transport category airplanes certified under Part 25 are required to have. This characteristic, unfortunately, is not widely understood by many of the pilots who operate these airplanes. This has led to the old joke, *"The purpose of the second engine on a light twin is to enable you to fly to the scene of the accident!"*

Combine the Facts that 1) The Airplane Multi-Engine class rating has been one of the "havens" for "diploma mills," leaving many multi-engine rated pilots with a rating but (in my humble opinion) very inadequate training with, 2) The wide misconception about the actual engine inoperative performance these airplanes are able to deliver, and you have set the stage for the very poor accident record these aircraft have developed. Exacerbating the afore mentioned issues are the fact that most these airplanes are easy to overload and are often flown year around for business and commercial use during instrument meteorological conditions (IMC). These issues have made the small, piston powered, multi-airplane difficult and expensive to insure for all but the most seasoned multi-engine pilots. This fact, plus, the completion from the new, high-powered, all-glass, fixed-gear singles (which have nearly identical speeds and cost much less to operate and insure), and you can readily see why prices are so depressed on piston, light-twin airplanes.

Light Twin-Engine aircraft first arrived on the scene during the years of 1936 and 1937 with the advent of the Beechcraft Model 18 (1936) and the Lockheed Models 10 & 12

(1937). Although Lockheed initially outsold the Beechcraft and was made famous by Amelia Earhart, WWII caused Lockheed to concentrate on manufacturing their heavier aircraft while Beechcraft massed produced the model 18 for the military. Thus, the Beechcraft model 18 was positioned to be the principle light twin to move into the business and charter markets after the war. Because of the Beech 18's operational cost, Piper aircraft introduced the PA23-150 (Apache) in 1954 and it became a very poplar training aircraft. (Most civilian-trained pilots in my generation received their initial multi-engine training in the Apache). These aircraft were certified under the old Civil Aeronautics Regulation Three (C.A.R. 3) which was even less restrictive than the later FAR Part 23. Information on aircraft certified under CAR 3 is principally derived from their Type Certificate Data Sheets (TCDS), which could be the subject of a whole article by itself.

By the 1960s light twins were becoming quite popular with Cessna, Beechcraft, and, Piper all joining the fray with multiple models. Some grandfathered back to the old CAR 3 certification and the newer ones being certified under the later FAR Part 23. These ranged from the 4 seat, 150 hp. (per engine) training type aircraft to the high powered cabin aircraft like the Beechcraft Model 65 Queen-Air. Some, like the Beechcraft Model 60 (Duke), Cessna Models 414 & 421, and the Piper PA31-P (Navajo) were even pressurized. The Pressurized airframes were heavier however, and suffered from the long climb times needed to reach their efficient cruising altitudes (15,000 feet thru FL 240). As the need for more power pushed horizontally-opposed piston engines beyond the 300 hp. levels, maintenance costs, operational complexity, and reliability problems all became issues which drove the cost of operation for these aircraft to levels that only corporate operators could afford. Then in 1964, Beechcraft introduced the Pratt & Whitney PT6, turboprop-powered, and pressurized Model 90 (King-Air) and the rest, as they say, is history. The PT6 engine solved the power requirements, time to climb, operational complexity, and reliability issues and rapidly drove the pressurized piston aircraft from the field. Piper responded with their PA31T-620 (Cheyenne) in 1974 and Cessna introduced their Model 425 (Conquest I) turboprop in 1980. Other manufacturers such as Aero Commander, Mitsubishi, and Fairchild also entered the market. Beechcraft had captured the lead however, and dominated the market with the other aircraft eventually all being driven out of production.

To Understand how "performance challenged" light twin engine aircraft actually can be, one needs to take a look at the requirements of FAR, Part 23 under which they are certified. Part 23 multiengine aircraft are divided into the following categories:

- **I. Reciprocating Engine powered airplanes of 6,000 pounds or less MTOW and a Vso 61 Knots or less – FAR 23.67 (a) (2).**
- **II. Reciprocating Engine powered airplanes of 6,000 pounds or less MTOW and a Vso of more than 61 Knots – FAR 23.67 (a) (1).**
- **III. Reciprocating Engine powered airplanes of more than 6,000 pounds MTOW and all turbo-propeller airplanes – FAR 23.67 (b).**
- **IV. Jet Engine powered airplanes of 6,000 pounds or less MTOW – FAR 23.67 (c).**

V. Jet Engine powered airplanes of more than 6,000 pounds MTOW – FAR 23.67 (d).

Bay "Super V" Conversion of Beech 35C Bonanza

Wikipedia Image

Reciprocating Engine powered airplanes of 6,000 pounds or less MTOW and a Vso 61 Knots or less have the following engine inoperative performance requirements:

a) The steady gradient of climb **or descent** at a pressure altitude of 5,000 feet must be determined.
b) The steady gradient of climb **or descent** at each weight, altitude, and ambient temperature within approved operational limits must be determined.
c) *Notice that no requirement exists for these M/E airplanes to ever have a positive climb gradient*.

Reciprocating Engine powered airplanes of 6,000 pounds or less MTOW and a Vso of more than 61 Knots have the following engine inoperative performance requirements:

a) The steady gradient of climb at a pressure altitude of 5,000 feet must be at least 1.5 percent. (This equals 180 feet per minute – fpm – at 120 Kts.).
b) The steady gradient of climb ***or descent*** at each weight, altitude, and ambient temperature within approved operational limits must be determined.

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c) *Notice that these are the first group of M/E airplanes to require any positive climb gradient*.
d) FAR 135.181 (a) (2) requires that multi-engine charter aircraft operating in IFR conditions must be able to climb at a rate of at least 50 fpm with the critical engine inoperative at a pressure altitude of 5,000 feet or the minimum enroute altitude (MEA), whichever is higher. This is the first group of airplanes that are typically able to meet this requirement.

Reciprocating Engine powered airplanes of more than 6,000 pounds MTOW and all turbo-propeller airplanes have the following engine inoperative performance requirements:

a) The steady gradient of climb at an altitude of 400 feet above the takeoff must be no less than 1 percent (this is 120 fpm at 120 Kts).
b) The steady gradient of climb at an altitude of 1,500 feet above the takeoff surface must be no less than 0.75 percent (90 fpm at 120 Kts).
c) *Notice that these are the first group of M/E airplane to require a positive climb gradient after takeoff.*

Jet Engine powered airplanes of 6,000 pounds or less MTOW have the following engine inoperative performance requirements:

a) The steady gradient of climb at an altitude of 400 feet above the takeoff must be no less than 1.2 percent (144 fpm at 120 Kts).
b) The steady gradient of climb at an altitude of 1500 feet above the takeoff must be no less than 1.2 percent (144 fpm at 120 Kts).
c) *Notice that the engine inoperative performance requirements keep increasing as airplane speed and weight increase*.

Jet Engine powered airplanes of more than 6,000 pounds MTOW have the following engine inoperative performance requirements:

a) The accelerate-stop distance must be determined
b) The steady gradient of climb after takeoff with the landing gear still extended must be measurably positive (any positive rate of climb)
c) The steady gradient of climb at an altitude of 400 feet above the takeoff must be no less than 2.0 percent with the landing gear retracted (240 fpm at 120 Kts).
d) The steady gradient of climb at an altitude of 1,500 feet above the takeoff must be no less than 1.2 percent (144 fpm at 120 Kts).
e) Engine inoperative discontinued approach steady climb gradient at an altitude of 400 feet above the landing surface must be no less than 2.1 percent.
f) *Notice that even though this is the highest required engine inoperative performance criteria, it still does not match the engine inoperative performance required from a Part 25 transport category airplane.*

The Airplane Configuration used by FAR Part 23 to determine the above performance is as follows:

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1) The critical engine inoperative, and (if propeller driven) its propeller in the minimum drag configuration or for turbo propeller airplanes, it is the position that the propeller rapidly and automatically assumes (i.e. auto-feather if installed).
2) The remaining engine at takeoff power
3) The landing gear retracted
4) The wing flaps in the takeoff position.
5) A climb speed of not less than 1.2 Vs1 (equal to V2 on a transport category airplane).

None of the Performance Requirements for FAR Part 25 Transport category airplanes, such as those that follow, are directly applicable to Part 23 airplanes.

1) Balanced Runway concept (i.e. the aircraft always has the capability to either stop on the remaining runway or to continue the takeoff after an engine failure)
2) V1min (slowest speed at which the aircraft is able to successfully continue the takeoff with an engine inoperative), V1max (the maximum speed at which the aircraft is able to successfully abort the takeoff) and V2 (minimum engine inoperative climb speed).
3) 1st segment climb (35 feet above the runway surface until landing gear retracted), 2nd segment climb (landing gear retracted until 400 feet or higher – must meet a steady climb gradient of at least 2.4 percent for twin engine airplanes, 3rd segment climb (during flap retraction), and 4th segment climb (from flap retraction until 1,500 feet above the takeoff elevation).
4) Missed approach engine inoperative steady climb gradient of at least 2.1 percent (252 fpm at 120 Kts).

Probably the Lowest Performance light twin ever produced was the Champion 402 (Lancer) aircraft. This was a failed attempt to produce a very inexpensive, light, multi-engine training aircraft. It was a modified Champion 7FC aircraft (tricycle gear version of the Champion 7EC aircraft). The Lancer had two Continental 0-200A, horizontally-opposed, four cylinder engines of 100 hp. each, fixed landing gear, fixed pitch propellers, and a MTOW of 2,450 pounds. It was reputed to not even be capable of engine inoperative level flight at any altitude, which made the rather poor performing Piper Apache seem like a stellar aircraft. Many of the multiengine instructors during the 1960s were still WWII pilots who “cut their teeth” on military aircraft. While they held the Piper Apache in disdain because of its very marginal engine inoperative performance, they totally rejected the Champion Lancer. Thus it was discontinued the same year it was introduced (1963) with only 23 aircraft produced.

Limited Production, light twin aircraft were the Bay “Super V” twin engine conversion of the Model 35C Bonanza, the UC-1 “Twin-Bee” conversion of the Republic Sea-Bee (23 of these were produced between 1965 and 1987, with 15 still in service in the US) and the newly designed Wing Derringer (12 aircraft were produced in the early ‘60s)

Other Twin Engine aircraft of the period were the Grumman American GA-7 (Cougar) of which 115 were produced in 1978 and 1979. The Aero Commander 500 series was made famous by Bob Hoover, but suffered from spar fatigue issues in later years. Twenty-four aircraft have been lost to wing failures in-flight, while another 35 aircraft were found to have spar cracks during maintenance inspections. The Mitsubishi MU-2 had full span flap and used spoilers for roll control. This made the aircraft handle differently than other light twins and resulted in a high accident rate when the aircraft began being operated by secondary owners without the benefit of factory training. This caused the FAA to issue an SFAR requiring that all MU-2 pilots receive specialized pilot training before flying this aircraft, even though a type rating is still not required.

This completes our introduction to the subject of light multiengine aircraft and seems an appropriate place to break for this month. Next month we will begin digging into the training processes, procedures and additional knowledge required to both obtain the multiengine class rating and safely operate these airplanes.

The thought for this month is "***Men occasionally stumble over the truth, but most of them pick themselves up and hurry off as if nothing had happened.***" **Winston Churchill –** So until next month, be sure to **Think Right to FliRite!**

Champion 402 Lancer in front of Piper PA23 Apache

2003 Sun-and-Fun at Lakeland, FL ***Wikipedia Image***

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