Performance calculations

Crunching the Phenom 100's takeoff numbers

BY BEN MARCUS

Although older jets use a blizzard of paper charts and tables to calculate performance, newer models take advantage of technology to provide more precise and versatile data. Embraer, for example, provides three ways to perform takeoff performance calculations for the new Phenom 100. One is to use the Simplified Takeoff Analysis paper charts in the Airplane Flight Manual. It may seem like a throwback; however, the charts provide much more precise data than older types. This may be the easiest method for many.

To begin, locate the page for the correct takeoff pressure altitude, flap setting, and anti-ice condition. Let's practice by looking up the takeoff performance data for a takeoff from Van Nuys, California (VNY), at a temperature of 35 degrees Celsius/95 degrees Fahrenheit, and a weight of 10,470 pounds. Van Nuys' elevation is 803 feet msl, so let's locate the page for a 1,000-foot pressure altitude, flaps one, dry runway, and anti-ice off.

Next, find our weight of 10,470 pounds at the top of the table and move your finger down that column until you reach the row for 35 degrees Celsius. You'll see that our takeoff runway required is 4,980 feet and our V_1, V_R, and V_2 are 106, 106, and 107 knots, respectively. At the bottom of the column you'll see that our V_{FS} (the speed where the aircraft will fly with flaps up) is 129 knots. The climb limit weight is located in the far right column for each temperature row. In this case, it's 10,470, the maximum certificated takeoff weight for the Phenom 100.

Other methods for computing takeoff data use Embraer software applications. Embraer certified the Phenom 100 using a takeoff performance calculation method unique among light jets. This certified data is contained in software called the Optimized PERformance Analyzer, or OPERA. This software is a part of the AFM and is provided on a CD-ROM.

The OPERA software allows pilots to input a large number of variables to determine the precise performance that can be expected from the airplane. These variables include such basics as weight, temperature, and runway length, as well as more detailed considerations such as anti-ice On or Off, runway slope, runway contamination, obstacles in the takeoff path, desired second-segment level-off height, and automatic thrust reserve (ATR) On or Off. ATR automatically boosts thrust on the operating engine after an engine failure. The OPERA system is very sophisticated, but it's as complex as it is capable. So to make calculating takeoff performance simpler, Embraer devel-

PHENOM BY EMBRAER

PHENOM 100
Airplane Flight Manual
Performance

SIMPLIFIED TAKEOFF ANALYSIS

FLAPS 1 – DRY RUNAWAY – ANTI-ICE OFF

Airport Pressure Altitude: 1000 ft

TEMP (°C)	TAKEOFF WEIGHT (lb) — MINIMUM REQUIRED RUNWAY LENGTH (ft) – LIMITATION CODE $V_1/V_R/V_2$ (KIAS)							
	8200	8600	9000	9400	9800	10200	10470	CLIMB LIMIT WEIGHT
-40	2465 93/93/99	2437 92/92/97	2467 92/95/100	2689 96/98/102	2916 99/101/104	3148 102/103/106	3308 104/105/107	10470
-35	2510 93/93/99	2482 92/92/97	2507 92/95/100	2733 95/98/102	2964 99/101/104	3201 102/103/106	3364 104/105/107	10470
-30	2555 93/93/99	2527 92/92/97	2547 92/95/100	2777 95/98/102	3013 99/101/104	3254 102/103/106	3420 104/105/107	10470
-25	2600 93/93/99	2571 92/92/97	2588 92/95/100	2822 95/98/102	3061 99/101/104	3307 102/103/106	3476 104/105/107	10470
-20	2645 93/93/99	2617 92/92/97	2630 91/95/100	2868 95/98/102	3112 99/101/104	3362 102/103/106	3534 104/105/107	10470
-15	2690 93/93/99	2662 92/92/97	2672 91/95/100	2915 95/98/102	3163 99/101/104	3416 102/103/106	3591 104/105/107	10470
-10	2735 93/93/99	2707 92/92/97	2716 91/95/100	2962 95/98/102	3214 99/101/104	3471 102/103/106	3650 104/105/107	10470
-5	2780 93/93/99	2751 92/92/97	2759 91/95/100	3009 95/98/102	3265 99/101/104	3527 102/103/106	3708 103/105/107	10470
0	2822 93/93/99	2793 92/92/97	2802 91/95/100	3056 95/98/102	3316 99/101/104	3582 101/103/106	3766 103/105/107	10470
5	2864 93/93/99	2834 92/92/97	2845 91/95/100	3104 95/98/102	3368 99/101/104	3639 101/103/106	3826 103/105/107	10470
10	2903 93/93/99	2874 92/92/97	2892 91/95/100	3155 95/98/102	3424 99/101/104	3700 101/103/106	3890 103/105/107	10470
15	2943 93/93/98	2913 92/92/97	2942 91/95/100	3209 95/98/102	3483 99/101/104	3763 101/103/106	3957 103/105/107	10470
20	2981 93/93/98	2951 91/92/97	2991 91/95/100	3263 95/98/102	3541 99/101/104	3826 101/103/106	4023 103/105/107	10470
25	2997 92/92/97	2967 91/93/97	3089 92/95/100	3369 95/98/102	3654 99/101/104	3948 102/103/106	4150 104/105/107	10470
30	2879 88/90/95	3040 90/93/97	3328 94/96/100	3623 97/99/102	3925 100/101/104	4237 103/104/106	4453 105/[illegible]	10470
35	2986 88/91/95	3282 92/94/97	3586 95/97/100	3899 98/99/102	4222 101/102/104	4556 104/105/106	4980 106/106/107	10470
40	3218 90/92/95	3531 93/94/97	3853 96/97/100	4186 100/100/102	4638 103/103/104	5338 105/105/106	-	10313
45	3458 91/92/95	3791 94/95/97	4135 98/98/100	4718 101/101/102	-	-	-	9768
48	3607 92/92/95	3954 95/95/97	4474 98/98/100	5198 101/101/102	-	-	-	9446
V_{FS}	115	118	120	123	125	127	129	

This page from the Phenom 100 Airplane Flight Manual makes it easy to determine takeoff V-speeds. Follow the column for the appropriate airplane weight until it intersects the ambient temperature row, then read the numbers in the red circle. Required field length is 4,980 feet, and V_1, V_R, and V_2 are located beneath. At the bottom of the chart is the V_{FS}—the speed to use in the third climb segment.

oped easy-dispatch software, or EDS, which provides a much friendlier graphical user interface and simpler outputs.

Embraer includes in the AFM some selected takeoff performance data in paper form. These Simplified Takeoff Analysis charts, like the one we used to calculate our performance departing Van Nuys, will do the job under most conditions, but do not necessarily allow optimum aircraft performance.

These charts are provided in the AFM only for limited conditions and are all based upon ATR Off, which limits second-segment climb and climb-limited takeoff weight compared to takeoffs made with ATR On. The climb-limited takeoff weight is the maximum weight under which the standard Part 25 2.4-percent gross second-segment climb gradient can be met. Departure procedures (DPs) often require a much greater climb gradient and this performance can only be calculated by using OPERA or EDS. AOPA

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TOLD you so

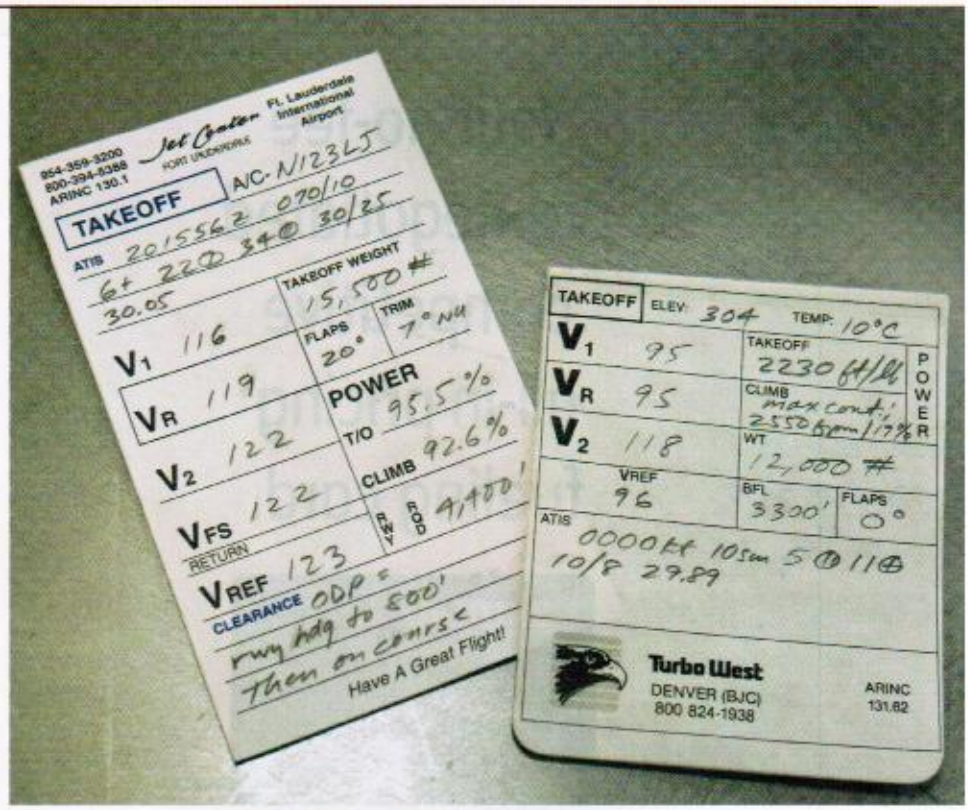
Takeoff and landing data—right before your eyes

BY MARK R. TWOMBLY

It's easy to think that with the way cockpit automation is going, it won't be long before the optional equipment list for new airplanes includes an actual living, breathing pilot stationed in the cockpit to handle the controls and manage the flight. We're not there yet, but thanks to technology, many of the hands-on tools pilots once considered essential are indeed becoming anachronistic.

Like a pen or pencil. Who needs one when hidden computers do all the busy work, perform all the calculations, and post the desired results? Just enter the raw data on a keyboard or touch screen and up pops the useful information on the appropriate electronic display. Since microprocessors are doing the heavy lifting, the only reason to carry a pen is to sign the fuel receipt at the FBO counter.

With all the dazzling capabilities, features, and performance that state-of-the-art integrated avionics systems wield, why go through the drudgery of researching, computing, and actually writing down matter-of-fact flight information such as takeoff and landing data? Turns out there are good reasons to do just that.



Sample TOLD cards showing representative V-speeds, takeoff distances, weights, and airport conditions for a Learjet 31A (left) and a King Air B300 (right). On the flip side of these cards are spaces for similar data for approach and landing V-speeds and distances, based on conditions at the destination airport.

For one thing, we're still in a transition phase when it comes to avionics. Lots of turbine-powered aircraft are flying around with a panel full of old-school instruments and gauges that still function quite efficiently, thank you. The only way to generate takeoff and landing data (TOLD) in these airplanes is to take out your personal writing implement, along with the performance charts, and do it yourself.

One popular shortcut to researching performance numbers the old-fashioned way—consulting the flight manual—is to use a software program such as EFB Pro (www.cavucompanies.com), Ultra-Nav (www.ultranav.com), or Atlas from Airport Performance Group (www.apg.aero/MW) to do that work. Some integrated avionics suites will configure electronic