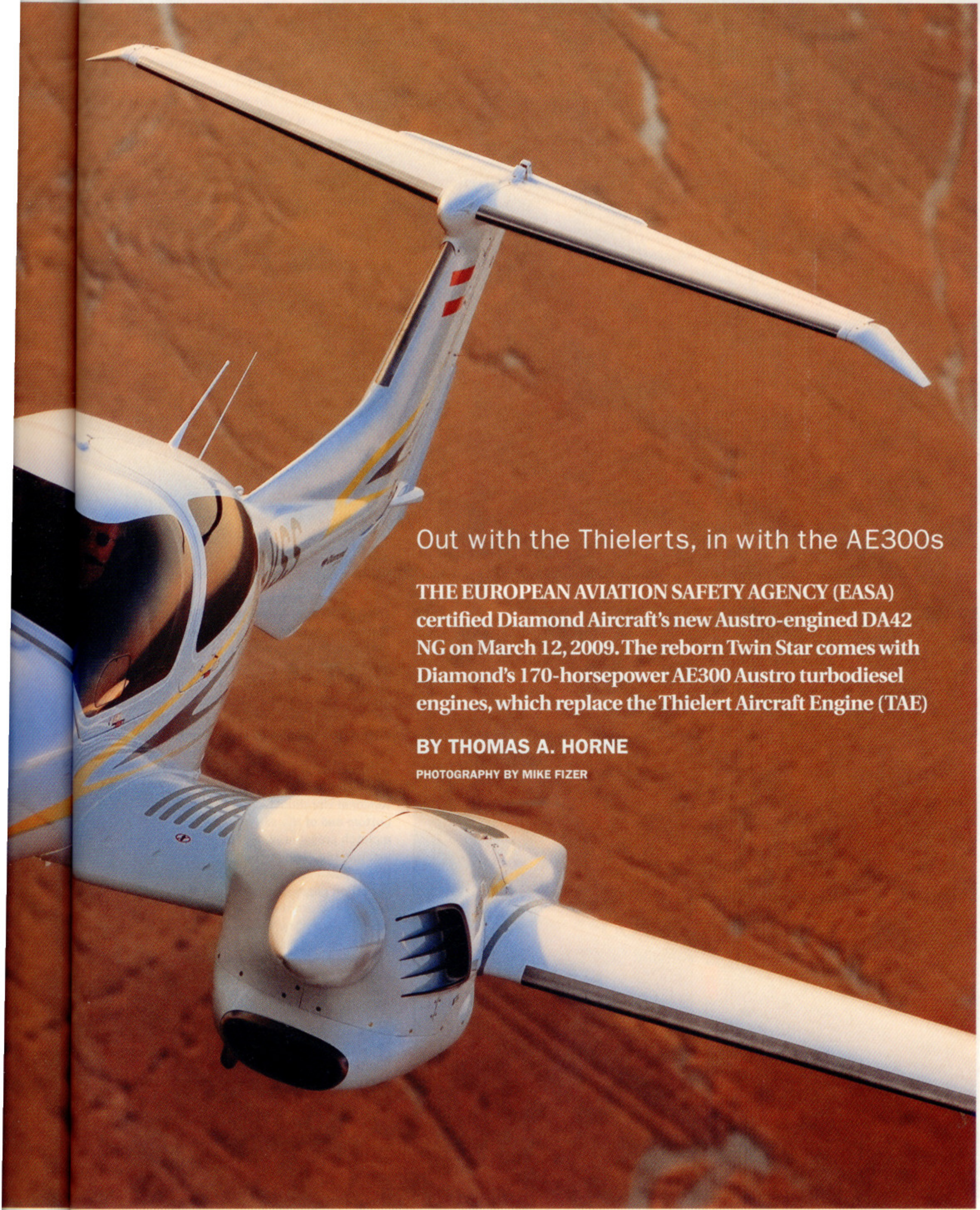
# DA42 do-over

Out with

**THE EUROI certified Dia NG on Marc Diamond's l engines, wh**

**BY THOMAS**

PHOTOGRAPHY BY

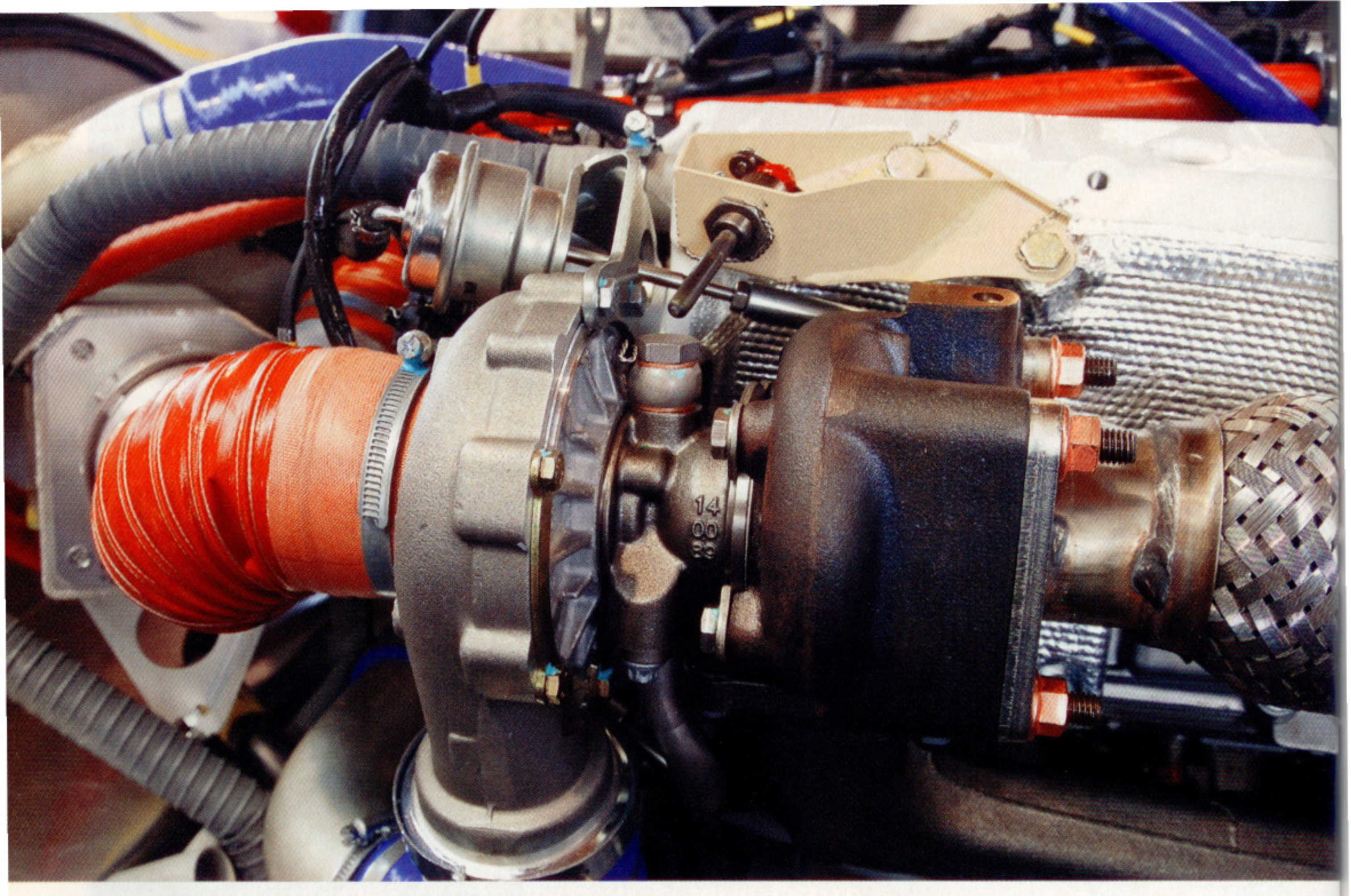


# Out with the Thielerts, in with the AE300s

**THE EUROPEAN AVIATION SAFETY AGENCY (EASA) certified Diamond Aircraft's new Austro-engined DA42 NG on March 12, 2009. The reborn Twin Star comes with Diamond's 170-horsepower AE300 Austro turbodiesel engines, which replace the Thielert Aircraft Engine (TAE)**

**BY THOMAS A. HORNE**

**PHOTOGRAPHY BY MIKE FIZER**



The AE300 Austro engine is, at heart, the Mercedes-Benz two-liter powerplant used in that company's A-class small sedans (which are not sold in the United States). One of its many useful features is a fire-detection system. The AE300's turbocharger (above) comes with a probe—the elongated rod next to the turbo's housing—that detects a fire and sends a warning to an annunciator on the DA42 NG's Garmin G1000 primary flight display. The AE300's dynamic torsional vibration damper (right, in the bottom end of the engine) may look like a clutch pressure plate, but it uses an elastomeric coupling to tame the engine's power pulses as they make their way to the reduction gearbox. The cast-iron crankcase and top end are the same as the automobile engine's, but components such as the high-pressure fuel pump (right, mounted on the engine's top end) were designed specifically for the AE300. The G1000 suite (left) includes Garmin's GFC700 integrated flight control system and autopilot. Full authority digital engine controls (FADEC) do away with propeller and mixture controls, leaving you with just two levers for power control.

turbodiesels that power the first-generation Twin Stars. The engine swap couldn't come soon enough, according to Diamond officials. The DA42's TAE 1.7-liter, 135-horsepower engines developed a reputation for lousy reliability and frequent, expensive maintenance and overhaul intervals. TAE gearbox inspections, clutch replacements, and high-pressure fuel pump replacements come every 300 hours, and cost thousands. Even worse, shipping those components back to the TAE factory in Germany costs thousands more. On top of this, TAE engines can't be overhauled; they are traded in for a new, replacement engine—so the TAEs have TBRs (times between replacement), not TBOs.

A widely publicized 2007 crash of a TAE-powered DA42 in Speyer, Germany, brought Diamond and TAE to a war of words. A pilot found his Twin Star with a dead battery, so he used a power cart to start one engine, disconnected the external power, and then started the other engine. The POH says to remove a depleted battery, charge it, and then reinstall it for engine starts. During the subsequent takeoff the battery evidently was still not fully charged.

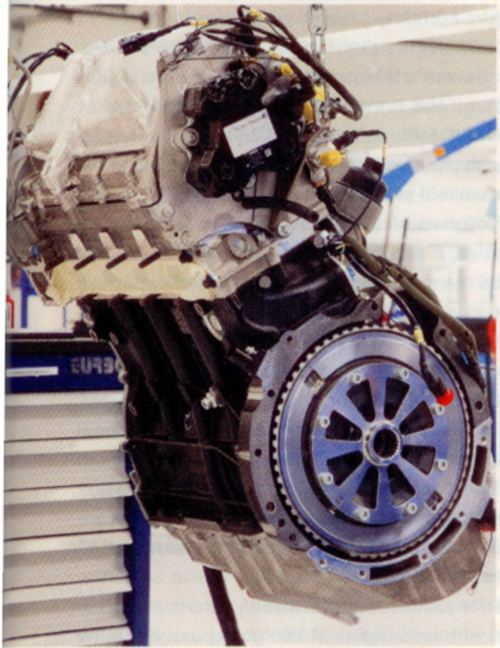
When the landing gear was retracted, system voltage dropped below 8.5 volts for a mere 0.18 milliseconds. That's not much time, but enough to interrupt power to the engine control units (ECUs). Result: Both engines quit, the propellers went to the feather position, and the airplane settled off the end of the runway. A fix—adding a separate battery to each ECU, to ensure they remain powered to prescribed levels—was soon developed. There were no injuries in this accident, but the damage was done.

The bad news wasn't over. Following an investigation that revealed financial irregularities, TAE declared bankruptcy in February 2008. Diamond, long dissatisfied with TAE, had by then decided to go it alone and switch engines.

The DA42 with 180-horsepower Lycoming IO-360 engines—dubbed the DA42 L360—was certified for the North American market in August 2009 when it earned FAA and Transport Canada approval. More about the DA42 L360 is in "Cleared for the Option: Diamond's DA42 L360," on page 54.

But the biggest news is Diamond's development of the two-liter, 170-horsepower AE300 Austro engines for its DA42 NG (next generation) Twin Star. Currently the DA42 NG is being marketed in western Europe, Russia, and several Asian nations. But by early 2010 NGs should be FAA certified, Diamond says. Retrofit kits to provide AE300s for the 500-strong worldwide Thielert-powered DA42 fleet are also in the works. The NG's AE300s are already FAA-certified.

Diamond reports that it has received expressions of interest in



## SPECSHEET

### Diamond DA42 NG
**Base price: $726,500**

#### Specifications

Powerplants ......... 2 Austro Engine AE300, 170-hp turbodiesels
Recommended TBO ................. 1,000 hr
Propellers .............MT composite, 3-blade, constant-speed, full feathering
Length ..................................... 28 ft 1 in
Height ........................................8 ft 2 in
Wingspan ........................................44 ft
Wing area ...............................175.3 sq ft
Wing loading ......................23.89 lb/sq ft
Power loading ..........................12.3 lb/hp
Seats ...................................................4
Empty weight ............................3,119 lb
Useful load ...............................1,070 lb
Payload w/full fuel, standard fuel tanks ..... ..........................................865 lb
Long-range tanks .........................719 lb
Max takeoff weight......................4,189 lb
Fuel grade ...........................Jet A, Jet A-1
Fuel capacity, standard tanks ..........50 gal
Long-range tanks .........................76 gal
Oil capacity, ea engine........................ 7 qt
Baggage capacity, nose.....................66 lb
Baggage capacity, aft of rear seats..100 lb

#### Performance

Takeoff distance, ground roll ........1,503 ft
Takeoff distance over 50-ft obstacle ........ ..........................................2,405 ft
Max demonstrated crosswind component .. ..........................................25 kt
Rate of climb, sea level .............1,180 fpm
Single-engine ROC, sea level.........210 fpm
Cruise speed/endurance/range (fuel consumption, ea engine)
@ 80% power, 8,000 ft, standard tanks... .....................162 kt/3 hr (7.0 gph)
@ 75% power, 12,500 ft, long-range tanks .....................171 kt/5 hr (6.5 gph)
Max operating altitude ..............18,000 ft
Landing distance over 50-ft obstacle ......... ..........................................1,950 ft
Landing distance, ground roll ........1,200 ft

#### Limiting and Recommended Airspeeds

$V_{MC}$ (min control w/one engine inoperative) ............................................ 76 KIAS
$V_X$ (best angle of climb) ............... 90 KIAS
$V_Y$ (best rate of climb).................. 90 KIAS
$V_{YSE}$ (best single-engine rate of climb) ........ ............................................ 85 KIAS
$V_A$ (design maneuvering) ............ 122 KIAS
$V_{FE}$ (max flap extended),
approach flaps ........................ 133 KIAS
landing flaps ........................... 113 KIAS
$V_{LE}$ (max gear extended) ........... 188 KIAS
$V_{LO}$ (max gear operating)
Extend ................................... 188 KIAS
Retract ................................... 152 KIAS
$V_{NO}$ (max structural cruising)....... 188 KIAS
$V_{NE}$ (never exceed) ..................... 188 KIAS
$V_R$ (rotation) ................................ 80 KIAS
$V_{S1}$ (stall, clean) ........................... 69 KIAS
$V_{SO}$ (stall, in landing configuration) ............ ............................................ 62 KIAS

*For more information, contact Diamond Aircraft Industries Inc., 1560 Crumlin Sideroad, London, Ontario, Canada N5V 1S2; telephone 519-457-4000; fax 519-457-4021; www.diamondaircraft.com.*

*All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, sea level, gross weight conditions unless otherwise noted.*

the DA42 NG from many American customers—especially from TAE-powered DA42 position-holders and existing DA42 owners.

**Pure Mercedes**

Like the Thielerts, the AE300s use Mercedes-Benz automobile engines as their platforms. But where TAE made modifications, Austro sticks with the stock Mercedes. The AE300's pistons, camshafts, valves, cylinder heads, and crankshaft are straight from the Mercedes assembly line. Austro figured that with Mercedes' experience—and its $550 million investment in development and testing costs—the two-liter, inline four-cylinder would be best if left as originally designed. This includes a cast-iron crankcase, which TAE discarded in favor of a lighter, aluminum case. Austro added turbochargers and electronic components of its own choosing.

Bosch Engineering provides the NG's full-authority digital engine controls (FADECs), as well as its high-pressure fuel pump, which boosts fuel pressures to some 26,000 psi, about 6,000 psi greater than the pressures in the TAE engines. This means better atomization as fuel is delivered through a common fuel rail feeding directly into each cylinder. The timing of the fuel pulses is governed by the AE300's electronic engine control units. The AE300's gearboxes are from HOR Technologie, and the composite-construction, three-blade, electrohydraulically controlled propellers are from MT-Propeller.

In another departure from the TAE engine design, Austro uses a dynamic torsional vibration damper to protect the gearbox from the very high power pulses transmitted from the turbodiesel's pistons to the crankshaft. At first glance, the vibration damper looks like a clutch affixed to the end of the crankshaft, but it's really an elastomeric coupling (think of a large rubber doughnut) with a flywheel at its outer perimeter. The coupling floats a few degrees with the power pulses, diminishes the highs and lows of the pulses, and matches the inertia of the crankshaft and propeller. The Thielert engines used an automotive clutch to dampen vibrations—a design that causes the clutch to wear, which explains TAE's 300-hour clutch replacement intervals.

## Cleared for the option: Diamond's DA42 L360

**A Lycoming-powered multi-trainer for the future**

One look at the cowlings of the DA42 L360 and you know it has a pair of flat-four engines. The "L360" name stands for this DA42's 180-horsepower Lycoming IO-360 engines (right).

Although Diamond sees its new DA42 NG as primarily an owner-flown airplane, the same can't be said for the new, $599,800, Lycoming-powered DA42 L360. This version of the DA42 is aimed to a large degree at the U.S. training market. The choice of Lycoming's 180-horsepower IO-360 engines was obviously a response to the IO-360's popularity in the United States, its familiarity to mechanics, and the abundance of Lycoming parts and expertise. It's also a response to the needs of some 130 American owners stuck with maintenance-hungry Thielert Aircraft Engines (TAE) powerplants. As of this writing (December 2009) more than 30 DA42 L360s had been sold, including 10 retrofit kits. Swapping your old Thielert Centurion 1.7 or 2.0-liter engines for a pair of IO-360s will cost you $125,000—a price that includes labor.

Diamond had been experimenting with the idea of an IO-360-powered DA42 for a long time. In 2005 I flew a prototype at Diamond's Austrian factory and was impressed by the extra 90 horsepower (the TAEs were rated at 135 horsepower). The prototype leapt off the runway and had a truly impressive climb rate.

I flew a DA42 L360 with Diamond test pilot Rob Johnson at Diamond's London, Ontario, facility. As with the prototype, the airplane had sprightly takeoff performance—even on a 90-degree day. Initial rates of climb at the airplane's 90-knot $V_{YSE}$ settled around 1,300 fpm, and it wasn't long before we were at 5,000 feet, doing 160 KTAS while burning 11 gph per side; power was set at 24.5 inches of manifold pressure and 2,400 rpm.

Although the L360's power and fuel capacity (76 gallons) make it a great cross-country machine, it was the airplane's behavior in training exercises that interested me most. First, some full-power departure stalls. Johnson demonstrated one, with the goal of showing that the airplane simply wouldn't stall in this condition. With the full 360 horsepower and 26 degrees of nose-up pitch, the airplane was still climbing at 40 KIAS and 1,650 fpm. "It'll just hang there like a helicopter," Johnson said. To meet certification rules that require conventional stall behavior—complete with a break—Diamond limited maximum continuous power to 75-percent power for five minutes when doing power-on stalls. This turns out to be 20.5 inches of manifold pressure and 2,700 rpm at 5,000 feet. At this power setting, $V_{S1}$ came at 50 KIAS, accompanied by the usual prestall buffeting.

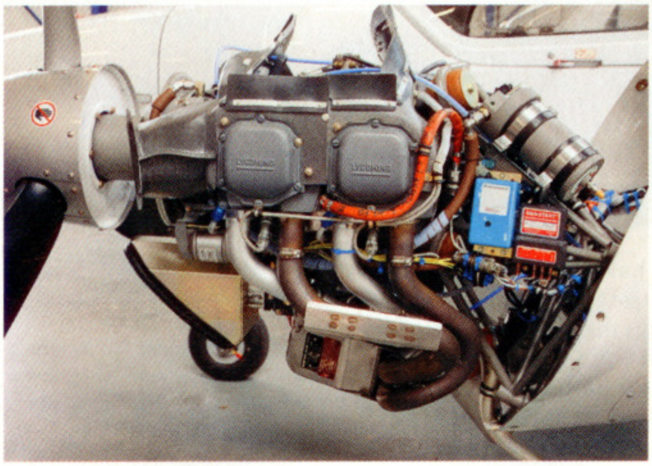
I was expecting a little more drama for the $V_{MC}$ demonstration (minimum control speed with one engine at idle power and the other going full blast, five degrees of bank into the "good" engine, gear up, Diamond says that at 80-percent power the AE300s are 20 percent more efficient than the Thielerts, and that the extra 70 horsepower gives the DA42 NG a 183 KTAS maximum cruise speed, compared to the Thielert-powered DA42s' maximum speed of 160 KTAS. The AE300s will begin with 1,000-hour recommended times between overhaul (TBO), and their high-pressure fuel pumps will begin with 600-hour maintenance intervals. These times may be extended, based on service history. Ultimately, Diamond is aiming for a 2,000-hour engine TBO.

**NG cross country**

As for operating the AE300s, simplicity is the word. Starting is a matter of turning on the master switches and turning the start keys. Diamond says to warm up the engines until oil temperatures reach 122 degrees Fahrenheit and coolant temperatures (the engines are liquid-cooled) reach 140 degrees F. Then, after completing all the pretakeoff checklist items, it's time to take off. Shove the throttles full forward, wait for 80 knots, then rotate and climb out at the $V_{YSE}$ of 85 knots.

At altitude, Diamond test pilot Soeren Pedersen watched as I performed a stall series. There was plenty of warning, and one of the stalls gave a break to the left. Single-engine work was unremarkable, with plenty of rudder power to counter yaw and at our light weight (two pilots, no bags), single-engine climb rates were in the 400-fpm neighborhood at 6,000 feet and plus 1 degree C.

For landing, the gear can be extended right up to $V_{NE}$, so the timing is your choice. Approach flaps can go down at 133 KIAS, and landing flaps at 113 KIAS. Very little trim change is required for gear or flap extension or retraction, by the way. On final, aim for a reference speed of 85 KIAS, then close the throttles and flare when the time seems right. One idiosyncrasy has to do with the brakes. They're activated by pushing on the tops of the electrically adjustable rudder pedals, as usual, but the pedals themselves seemed on the short side—so rudder steering on the ground sometimes meant that brakes were inadvertently applied as well. Maybe it's just me. The landing gear have been beefed up to accommodate the extra 176 pounds of the AE300s and their mounts,



**Look, ma, no FADECs. Instead, the L360 has a conventional set of dual throttle, propeller, and mixture controls—a nod to the airplane's market niche as a multiengine trainer.**

**and takeoff flaps), inasmuch as the airplane's $V_{MC}$ is posted as 56 KIAS, and its $V_{SO}$ (stall in the landing configuration) is listed as 55 KIAS. With such a hair's-width margin from the stall, many feel this might be flirting a little too much with a $V_{MC}$ rollover.**

**I've always doubted the notion of a $V_{MC}$ being more or less on top of the stall speed as a safe condition. And yet, modern light multiengine airplanes such as the Piper Seminole and Beech Duchess were sold on their safety based on a narrow $V_{MC}$-$V_{SO}$ spread. Seems to me as though you're asking for a stall at maximum asymmetric thrust, and a potentially unrecoverable loss of control. Perhaps the thinking is that at altitude the yaw will come before the stall is reached—which is what happens in older twins with higher $V_{MC}$/stall spreads (at lower density altitudes, that is). But when $V_{MC}$ is close to the stall, it's turbulent, or the density altitude situation is just right, if you hit $V_{MC}$ and stall at the same time, you're going to roll big time.**

**Nevertheless, the L360 minded its manners as airspeed dropped near 56 KIAS, and with the ailerons held to a five-degree bank and the rudder at the stops, the heading began to wander ever so slightly. Then it was throttle back the "good" engine, lower the nose, and recover as airspeed rose. In all, the L360 complied with conventional, textbook $V_{MC}$-demonstration behavior. Even so, Diamond gives a $V_{SSE}$ (safe single-engine speed) of 80 KIAS—a full 24 knots above $V_{MC}$.**

**We shut an engine down for a check of single-engine climb performance, which brings up one big difference between the L360 and the FADEC-controlled DA42s. Instead of a single power lever for each engine, the L360 has the more conventional, six-lever mini-forest of center-console throttle, propeller, and mixture controls. At both $V_{YSE}$ and $V_{XSE}$, climb rates ranged from 200 to 350 fpm that 18 degree Celsius day at 5,500 feet.**

**As for avionics, the L360 comes with Garmin's G1000 as standard equipment. The first 24 airplanes were delivered with Bendix/King KAP 140 autopilots, which Diamond says flight schools prefer. Soon, however, it's expected that Garmin's GFC700 autopilot/flight control system may take over in popularity. TKS "weeping wing" ice protection is an option, but certification for flight into known icing was pending as we went to press.**

**The list of educational institutions that have signed up for L360s is long, impressive, and international; it includes Embry-Riddle Aeronautical University (12 deliveries so far), Utah State University, Pan Am International Flight Academy, the United Kingdom's Cabair, the pilot training schools for Belgium's Sabena Airlines (five airplanes), and Turkey's Turkish Airlines.**

**Whether destined for training or private use, the DA42 L360 serves as yet another affirmation of Diamond's willingness to both adapt to adversity and provide customers a choice between Jet-A and avgas. There are still a lot of Seminoles and Duchesses out there cranking out the airline-hopeful. But they're aging fast, and the L360 stands to gain.** ***—TAH***


but the stouter gear also give the NG a maximum takeoff weight 255 pounds greater than TAE-powered DA42s, and payloads 40 to 50 pounds greater.

I was fortunate enough to fly a DA42 NG on a 250-nm cross-country, from the Diamond factory in Wiener Neustadt, Austria, to Fürstenfeldbruck, Germany. Along the way, maximum continuous power true airspeeds worked out to be 176 knots at 92-percent power, burning 8.2 gph per engine. This was at 8,000 feet and at plus 2 degrees C; I was told that we'd have gone seven or eight knots faster at 10,000 or 12,000 feet. Except for navigating the hodgepodge of controlled airspace along the way, flying the NG was a breeze. Just set the power and the FADECs do the rest. Like all DA42s, the NGs come with Garmin G1000 avionics suites, but what's new is the bezel-mounted, integrated GFC 700 autopilot; earlier DA42s came with Honeywell Bendix/King KAP 140 autopilots. The GFC 700 lets you automate your flying to your heart's content. The FLC (flight level change) function, for example, even lets you climb or descend at selected speeds or rates. Garmin's synthetic vision technology (SVT) will soon become an option.

Planespotters will have an easy time picking out an NG. There are prominent humps on the cowlings that accommodate the turbochargers, and the canopy has been enlarged for better visibility. Also, vortex generators have been added to the wing sections inboard of the engines. These help maintain the slow-speed handling characteristics of the NG's lighter predecessor.

**The near future**

While DA42 NGs are expected to hit the American market sometime soon, the American price is still undetermined. But in Europe, NGs are selling for 528,000 euros, which equates to about $726,500. This is for an airplane without oxygen and without the TKS ice protection system, which can be ordered with certification for flight into known icing. Diamond says that it expects to have NGs in the hands of more than 70 customers worldwide by early 2010. Diamond also plans to sell European DA40s with the AE300 engine.

For the 130 or so Thielert-powered DA42s in North America, an AE300 retrofit will be pricey. Diamond quotes European customers 99,000 euros/$145,000 to do the job; this includes not just the engines, but also their mounts, cowlings, new propellers, and other firewall-forward components. The other DA42 program, the DA42 L360, has already put Lycoming-powered TwinStars in training fleets around the world. These airplanes are built at Diamond's London, Ontario, manufacturing plant.

Whether AE300- or IO-360-powered, the newest TwinStars promise substantial improvements in both performance and reliability. Stay tuned for updates. AOPA

**Wing center sections (above) at Diamond's Wiener Neustadt, Austria, factory await their turn for fuel system and landing gear components. The Austro engine assembly facility is located right next to the Diamond plant. The Diamond visit culminated with a DA42 NG flight over the Austrian countryside (right), and a long cross-country over the Alps to the Füerstenfeldbrueck Airport, just west of Munich. This particular airplane was the first NG to be sold, and now makes its home in Sweden.**

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