

Tech focus

This month's focus is on flight testing.

Engineer chief sees bright days ahead for Eclipse 500

More than \$500 million and 2400 flight-test hours into the program as of July, **Eclipse Aviation** is nearing **FAA** certification for the Eclipse 500.

The fleet of five flight-test aircraft will have accumulated 3000-3500 hours by the time of first customer deliveries, according to the company's Vice President of Engineering, Ken Harness, who noted that not all of those hours are dedicated to FAA certification. Flight testing will con-

computer science, plus various technicians) have been working a very tight schedule for what the company calls the world's first "very light jet." The pace of work is particularly impressive since the company is relatively new and does not possess the kind of institutional processes some other business airplane makers do. The company employs more than 750 people altogether.

Flight testing for the six-seat Eclipse

500 began four years ago, but less than two years ago with a new engine from **Pratt & Whitney**.

"The amount of flying that we're doing on this program I've never seen done anywhere," said Harness. "It is amazing from a tempo perspective." Working 24/7, flight-test crews go on as many as eight sorties a day. Currently, some planes are being test-flown in Albuquerque, NM, (Eclipse headquarters) and some in Brownsville, TX, with the FAA on board. The testing at Brownsville at the moment goes from dawn to dusk.

Harness said Eclipse is breaking new ground in the use of telemetry for flight testing. He noted that engineers from **Boeing** have been to Albuquerque to check out the system, which was designed by Eclipse engineers.

An onboard transmitter allows for delivery of flight data up to 100 mi away to a ground station, "where you've got basically seven copilots, one in each engineering discipline, who can see real-time what's happening with the aircraft," Harness explained. "In fact, most issues that we find in flight are found by the engineers on the ground, not by the pilot." The ground station has a system that allows engineers to reduce the data real-time.

On top of the telemetry system is an onboard data-acquisition system with an optical disk that, immediately after the flight, plugs into a ground port. The data "gets spurted out to our network, and within 10-15 min of a flight that data is available to any engineer on the network so they can reduce the data very quickly," said Harness.

In most cases, one or more engineers accompany the test pilot during a flight to look at the data and get a physical feel for the plane. The pilot goes it alone during category A flying, which involves flight envelope expansion, stalls, and other dangerous tests. Data from these types of tests are most amenable to telemetry, Harness noted.

Aircraft N502EA was dedicated to pushing the flight envelope. The plane is



Eclipse already has cleared most flight-test hurdles for the 500.



Ken Harness, Vice President of Engineering, said the tempo of Eclipse 500 development has been "amazing."

tinue after certification for the purpose of continuous improvement, he said.

Overall, the development program, including flight testing, has gone very well. "The autopilot and electronic flight information systems are where we are right now," said Harness. "We've had a lot of other technical issues, and we've knocked them all down."

Powerplant and fuel system testing has gone particularly well, Harness said.

His 260 employees (including 180 engineers in various disciplines including



Engineers typically do not join the pilot on board for the more dangerous tests.



Although a relatively new company, Eclipse is a leader in the use of telemetry for flight testing. Here, Eclipse engineers read data real-time from a test run.

to be certified to 275 knot VMO (maximum indicated speed), but it was taken up to 325 knot. "We go much faster for flutter testing, we go much heavier for loads testing, and we go much further forward and aft in center of gravity than the customer will ever see," Harness said.

There have been no accidents during these maneuvers, but an actuator failure forced a test pilot early in the program to land with a collapsed right main landing gear. The pilot kept the wing off the ground until the last minute to limit damage. Eclipse engineers subsequently de-

signed a rub strip for the wing tip, a feature the company would not have included had the incident not taken place. In that sense Eclipse "turned a lemon into lemonade," Harness said. The actuator supplier is no longer on the program.

Engineers made many other revisions based on flight-test results. After high roll forces were experienced during a test flight, engineers modified gearing in the flight control system and resized the aileron.

Two of the five test planes will be licensed and used by Eclipse for internal

purposes such as corporate travel and marketing. The other three were more heavily modified for flight testing and will be used to certify options and to serve as tools in any future program.

The 500 is Eclipse's only active program, "although we do have some preliminary design activity behind the scenes," Harness said. "We don't talk publicly about future programs."

In anticipation of FAA certification, assembly has begun on several aircraft.

Patrick Ponticel

Flight-test engineers work to higher standard on SJ30-2

With its high speed and high performance but only single-pilot operation, flight-test engineers working on Sino Swearingen's SJ30-2 program had to prove performance parameters that combined elements of both FAR Part 23, which are reserved usually for small aircraft, and FAR Part 25, which are typically found with only commercial aircraft.

For example, the FAA in recent years redefined the reference stall speed for transport-category airplanes as a speed not less than the 1-g stall speed rather than the minimum speed obtained in a stalling maneuver. Because of its Mach 0.83 speed, the FAA required Sino Swearingen to test the SJ30-2 business jet to the same standard.

"Some engineers were not used to that," said Mario Asselin, Manager of Flight Sciences, Weights, and Future Programs for Sino Swearingen.

Neither were they used to VMU (vitesse minimum unstick) tests, which, like the 1-g stall test are not typically done on



Extreme pitch is not uncommon on takeoff for the SJ30, requiring Sino Swearingen flight-test engineers to conduct VMU testing more common on transport category aircraft.

business aircraft. In order to test slat and flap configurations, the aircraft takes off with its tail touching the ground.

Company minimum unstick speed testing on the SJ30-2 was completed last year during a series of flight tests in which the test pilots purposely abused the normal takeoff procedures by testing for

tail strike or stall capabilities at Vr (rotation speed). The SJ30 successfully demonstrated that it can safely take off and fly away from ground effects while maintaining extreme pitch attitudes without any occurrence of a tail strike or stall.

Pitch attitudes at takeoff were at extreme positions of up to 15° nose up,

explained Asselin. The tests opened the way to unrestricted rotation speed that provide low and easy takeoff speeds V2 and shorter takeoff distances.

A key milestone in the SJ30 flight-test program was completed earlier this year when the final flight test in actual icing conditions was completed in Provo, UT. This testing consists of the FAA requirement to complete a 45-minute hold in actual maximum continuous icing conditions, and was completed by test pilots Mark Fairchild, John Siemens, and flight-test engineer Schuyler Horn.

Other testing was completed for artificial ice shapes testing in Roswell, NM. This testing is required to demonstrate aircraft handling characteristics, includ-

ing stability, control, and stall characteristics, with simulated ice attached to the airframe, replicating what would accumulate on unprotected surfaces during flight in a 45-minute maximum continuous ice encounter

The SJ30 is equipped with electrically heated windshields and uses engine bleed air heat to anti-ice the wings and engines. Pneumatic boots are used to de-ice the horizontal tail. The approval flight involved 50 minutes of maximum continuous icing conditions and more than another hour of intermittent icing conditions, which resulted in a buildup of more than 4 in of ice on unprotected areas of the aircraft.

Last October, the aircraft received FAA

Type Certification, and the final test into known icing was required before the initial delivery to a customer. Other flight tests conducted prior to certification included extensive high-Mach lateral directional tests, engine in flight fire-suppression tests, in-flight unusable fuel tests, flight testing of engine operating characteristics and engine-out conditions, engine in flight, air start tests, noise compliance tests, extreme cold and severe hot weather operations tests, and engine-airframe natural icing tests.

The single-pilot SJ30-2 business jet has a range of over 2500 nm and operates at altitudes to 49,000 ft.

Barry Rosenberg

Cessna eyes satellite-based telemetry for flight testing

Flight-test engineers have lots of powerful instrumentation and data-collection tools at their disposal. But there are always some new and better tools they wish they could hang from their belts.

For David Bonifield, test pilot and Manager of Engineering Flight Test for Cessna, his wish list would be topped by improved telemetry systems.

Such a capability would have been particularly prized this year while the Cessna is immersed in flight-testing the Citation Mustang. The first production Mustang assembled in Independence, KS, serial number 0003, took flight June 15, two weeks ahead of schedule. That airplane will enter service this December as Cessna's first Mustang demonstrator

vested more than \$20.4 million in building expansion, adding more than 120,000 ft², and including a new flight-test building, new paint facility, and a new customer center with a showroom hangar for deliveries.

The three Mustang airplanes dedicated to certification are the Mustang prototype and serial numbers 0001 and 0002. Certification flight hours on the three airplanes total more than 1250 h. FAA certification is expected later this year. The first Mustang customer delivery is scheduled for the first quarter of 2007.

Many of the pilots in both the left and right seats of the Mustang during flight test are engineers.

"One thing you find is that many people in flight test are pilots—not all but a substantial number," said Bonifield, who has spent 32 years at Cessna. "The engineer who is a pilot possibly understands things from a different perspective from someone who isn't a pilot. That's not to say one is a better engineer than another. But even if they are just a private pilot they have a different understanding of stalls, airplane vibrations, and control forces."

That goes even for new hires into Cessna's flight test organization. Said Bonifield: "New people coming out of college we bring right into flight test, and in a lot of cases they do have a private pilot's license."

Barry Rosenberg



Cessna flight-test engineers will have to wait awhile before satellite transmission of telemetry data becomes cost-effective. Shown is the first Cessna Mustang in flight.

"One major area of improvement that we are watching—which is cost-prohibitive at the moment—is satellite-based telemetry systems," said Bonifield. "It would let us do flight testing anywhere in the world and have a satellite link to Wichita. We could do high-temperature ambient testing in Yuma, AZ, and rather than take a crowd of engineers with us we could just send a flight crew and back here in Wichita have twice as many engineers working the data."

aircraft. It is the fourth Mustang produced, and the first one that will not be used for FAA flight testing.

Mustangs 0004 through 0015 are currently on the production line at Cessna's assembly plant in Independence. The Mustang is the first jet-powered aircraft Cessna has ever built in Independence, which has been home to the company's piston-engine-aircraft manufacturing since 1996. To bring the Mustang to Independence, Cessna in-