Regional Silencer

Challenge of quieting smaller aircraft draws attention of European researchers

Graham Warwick Washington

When it comes to noise, regional aircraft may be quieter than long-haul airliners, but they struggle to match the reductions that have been achieved by the big jets over the years. This is one reason smaller aircraft have been given more time to comply with stricter noise limits coming later this decade.

Chapter 14 noise standards, which will take effect for new large-aircraft designs from the end of 2017 and require a cumulative reduction of 7 EPNdb (Effective Perceived Noise Level), will not be applied to aircraft weighing less than 55 metric tons (121,250 lb.) until 2020. This reflects the tougher task manufacturers face to significantly reduce airframe and engine noise in smaller aircraft.

With the sector's most successful manufacturer ATR, jointly owned by Airbus and Alenia Aermacchi, Europe is investing in research into reducing the noise impact of future 90-130-seat regional aircraft—whether powered by turboprops, geared turbofans or open rotors. In Japan, where the next commercial aircraft program to follow the Mitsubishi Regional Jet is just beginning to take shape, research into airframe and engine noise reduction also is gearing up.

For regional aircraft, noise from the landing gear and high-lift system is a major contributor to the total. Over the last couple of decades, Europe has run a series of research programs looking at airframe noise reduction, but they have focused on larger single- and twin-aisle aircraft. Among the biggest of these was Silencer, under which a low-noise main landing gear was test-flown on an Airbus A340. The OpenAir program, now winding up, has focused in part on the smaller A320 main gear.

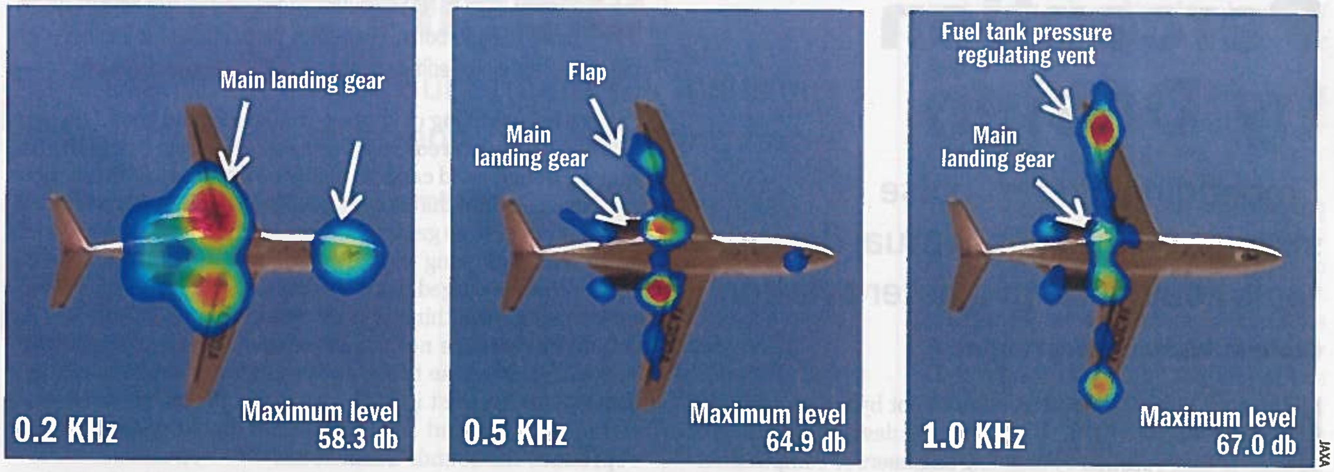
But Europe's €1.6 billion ($2.1 billion) Clean Sky public-private research program, and the €4 billion Clean Sky 2 follow-on now getting underway, has a regional aircraft project, led by the partners in ATR. Under the Green Regional Aircraft program within Clean Sky, the Low Noise Configuration project is demonstrating noise-reducing technologies for regional-turboprop landing gear and high-lift systems. The program is also looking at new configurations that would reduce noise.

Work on reducing airframe noise is focused on a 90-seat twin-turboprop with high-mounted wing and main gear housed in fuselage sponsons, similar to today's ATR 42/72. Over several projects, Europe has evaluated numerous noise-reducing technologies using computational aero-acoustics. Now, under the Allegra program, the most promising concepts will be tested on full-scale nose gear and half-scale main gear mock-ups in the wind tunnel at

Europe's Wenemor project has evaluated the effectiveness of a U-tail in shielding open-rotor noise.

TRINITY COLLEGE, DUBLIN

Altitude 60 meters, landing configuration, engine-idling condition (40% thrust), temporary level flight (120 kt.)



JAXA uses an acoustic phased array to identify airframe noise sources on aircraft in flight, here a Mitsubishi Diamond.

the Pininfarina design house in Italy.

The best solution emerging from the Allegra project will then be tested on a full-scale main landing gear in the DNW-LLF wind tunnel in the Netherlands, under the follow-on Artic program. Trinity College Dublin is the coordinator for both the €2 million Allegra and €1.4 billion Artic programs and also leads the €2 million Wenemor project to evaluate installation effects on noise for an open-rotor-powered 130-seat regional aircraft.

Aero-acoustic wind-tunnel testing under Allegra is scheduled to begin in October with the full-scale nose landing gear, and testing of the half-scale main gear is to begin in December, says Gareth Bennett, Trinity College Dublin project coordinator for all three programs. "In the Artic project, a full-scale main-landing-gear model will be tested and the best low-noise solution coming from Allegra main-gear testing will be compared to the baseline to assess the noise reduction," he says.

"We expect a noise reduction of about 40% compared to the basic solution," Bennett says. "This would allow us to meet the Acare noise target for a 90-passenger turboprop green regional aircraft." Acare, the Advisory Committee for Aeronautics Research and Innovation in Europe, has set noise and emissions targets for civil aviation to meet by 2020 and, beyond that, by 2050. Clean Sky's Green Regional Aircraft program is aimed at helping meet the 2020 targets.

Allegra is evaluating a suite of low-noise solutions for the nose landing gear and another set for the main gear. For the nose gear, concepts to be tested are: hub caps on the twin wheels; a windshield between the two tires; a spoiler formed by angling the forward nose-gear door; and perforated fairings. A 4-db reduction is expected from hub caps; 3.5 db from the spoiler, which creates a flow separation zone over the upper part of the gear; 2 db from the windshield preventing flow between the wheels; and 1.5 db from fairings that slow airflow through the perforations and deflect the rest away from the gear. (A challenge of noise reduction is that lowering one source reveals another, so savings are not additive.)

For the main gear, concepts to be tested are: perforated fairings; passive absorbers inside the gear bay; outer hub caps and axle fairings on the twin main wheels; and leg meshes. A single bay absorber is calculated to reduce noise by 1-2 db and applying sound absorbers to both front and rear bay walls for the Allegra tests is expected to reduce noise further. Meshes reduce local airflow velocity and turbulence over downstream gear components and are expected to reduce noise by at least 2.4 db. Outer hub caps and axle fairings, which do not interfere with brake cooling, should shave off about 1 db.

For the 130-seater being studied under the Green Regional Aircraft program, the Wenemor project involved wind-tunnel tests to assess the effectiveness of the airframe in shielding the noise from twin counter-rotating open rotors. The test campaign with a 1/7th-scale aircraft model in the Pininfaria low-speed tunnel was completed in May 2013; it evaluated pusher and tractor open rotors in different positions, with conventional L- and T-tail and unconventional twin-fin U-tail empennage configurations.

In Japan, meanwhile, results of previous noise-reduction research have been incorporated into the design of the Mitsubishi Regional Jet now in development. Mitsubishi says the 90-seat MRJ90 has a noise footprint 50% smaller than the competing Embraer E-190 due to a combination of wing and gear noise reduction and higher-bypass-ratio Pratt & Whitney PW1200G geared turbofans.

Planning for a second, larger jetliner, which would not enter service until around 2040, is beginning, and noise reduction is one of the areas of supporting research on which the Japan Aerospace Exploration Agency (JAXA) intends to focus. JAXA's Fquroh (pronounced "fu-kuroh," which means "owl" in Japanese) program involves the flight demonstration of airframe noise-reduction technology. The program has begun with flight tests of JAXA's Hisho flying testbed, a Cessna Citation Sovereign, over a phased array of microphones to identify and measure noise sources, such as flaps and gear, on the unmodified aircraft.

JAXA has identified several technologies it plans to flight test: perforated fairings for the landing gear that could reduce noise by 2 db; a flap edge "bulge" that reduces and relocates the tip vortices to minimize turbulent flow, promising a 2-3 db reduction; and a redesigned leading-edge slat with serrated cusp at the lower trailing edge to break up the vortices causing the turbulent flow that generates slat noise. These technologies are planned be flight-tested in partnership with aircraft manufacturers over the coming years.