US Government Conducts Flight Testing to Prove Noise Prediction Models

The FAA, Volpe, NASA and industry partner to conduct helicopter acoustic flight testing to understand and reduce noise that annoys communities.

By Douglas Nelms

In the last issue of Vertiflite, the author detailed the acoustics research being funded by NASA and the FAA (see “US Government Research Targets Helicopter Noise”, Nov/Dec 2017). The author now discusses the joint flight testing just completed. – Ed.

In the mid-1980s, NASA Langley Research Center developed a software package, called WOP-WOP (for obvious reasons), to predict main rotor noise based on specific helicopters performing specific maneuvers under specific conditions.

WOP-WOP was subsequently refined by Dr. Kenneth S. Brentner, a NASA acoustical engineer who left Langley to become a professor of aerospace engineering at The Pennsylvania State University. He developed the NASA WOP-WOP program into what is now called PSU WOP-WOP and is currently using that program in the ASCENT Project 38 studies [detailed last issue – Ed.].

NASA subsequently developed another noise prediction code, Aircraft Noise Prediction Program 2 (ANOPP2), now used for applications ranging from fixed-wing transport to rotorcraft noise. NASA will be using it to assess the accuracy of its noise predictions for a recently completed set of flight testing of six light and medium civil helicopters.

Joint Acoustic Flight Testing

Acoustics flight testing of helicopters is not new. Every civil helicopter model is required to undergo noise certification testing, although this testing is primarily concerned with the loudest noise that a helicopter can make, which occurs at or around the required test point of a six-degree angle descent for landing. With the development of acoustic prediction codes, however, helicopter flight testing has taken on new importance.

NASA, the US Federal Aviation Administration (FAA), the John A. Volpe National Transportation Systems Center (another branch of the US Department of Transportation), the US Army, industry and academia have been taking helicopters into the field for the past three decades, performing flight testing to validate the acoustical results of these rotorcraft noise prediction programs, as well as determining how that information can best be used.

AHS Community Noise Initiative

In recognition of the increasing community noise complaints and successful efforts to restrict helicopter usage, AHS International initiated an effort with the Helicopter Association International (HAI) to help the technical and regulatory community better understand and address helicopter noise and noise complaints. Go to www.vtol.org/noise to learn more or to download past articles, presentations and technical reports.
The FAA’s efforts in helicopter noise reduction are directed by Rebecca Cointin, the Noise Division Manager, within the Office of Environment and Energy at FAA headquarters in Washington, DC. According to Cointin, “the overall goal of the noise abatement procedures work is to incorporate the beneficial procedures into the … Fly Neighborly program. The FAA is collaborating with HAI and [AHS] on multiple elements of our helicopter research.”

NASA has been working on acoustical research “over many years,” Gorton said. “We’ve been doing acoustics research on helicopters since the 1970s, conducting flight tests and putting data into our database that has been used for modeling. But the part that is in the forefront now is the partnership with the FAA, looking at how we can design low noise flight profiles. We’ve looked at this before, but now we are going back around, using better tools, with the FAA involvement. The community really wants some answers that they can put into practice.”

The current efforts to predict and verify rotorcraft maneuvering acoustics essentially go back to tests done in June and July of 2011 using a Bell 430. The test was a joint effort by NASA, Bell Helicopter and the US Army, with NASA and the Army providing the ground instrumentation, ground personnel and test range, and Bell providing the aircraft.

NASA TM-2014-218266, “Maneuver Acoustic Flight Test of the Bell 430 Helicopter Data Report,” published in May 2014, documented the tests. The flights “gathered a total of 410 test points over 10 test days and compiled an extensive database of dynamic maneuver measurements. Three microphone arrays with up to 31 microphones in each were used to acquire acoustic data. Aircraft data included Differential Global Positioning System, aircraft state and rotor state information.”

The FAA stated that data from the 2011 NASA test was used for validation in the just-completed ASCENT Project 38 program designed to develop noise abatement procedures.

The 2011 tests were followed by flight testing at NASA Langley between September 2014 and February 2015 under a joint NASA/US Army program using an Airbus AS350-SD1 (an AStar with a Honeywell LTS101 engine) and a Sikorsky EH-60L (an electronic warfare version of the UH-60 Black Hawk).

The purpose of the exercise was to investigate the effects of varying altitudes and gross weights on noise generation, establish the statistical variability in acoustic flight testing of helicopters, and characterize the effects of transient maneuvers on radiated noise for medium-lift utility helicopters. The tests were conducted at altitudes ranging from 0 to 7,000 ft (2,100 m) above mean sea level.

The 2014–2015 tests were conducted in three phases, with three test sites “chosen to have the widest possible density altitude variation and nearest to where the aircraft were based” NASA said. The EH-60L was based at NASA Ames, while the AS350-SD1 was based at Riverside and Hollister, California. Specifics of the tests were recorded in NASA TM-2016-219354, “Helicopter Acoustic Flight Test with Altitude Variation and Maneuvers,” and in a similar paper presented at AHS International’s Forum 72.

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* When viewed from above, these Airbus helicopters rotate clockwise, while the Bell and Robinson helicopters rotate counter-clockwise.
Recent Flight Testing

The just-completed acoustic flight testing effort was a joint NASA/FAA/Volpe/Army venture, using various helicopter types during two phases in two separate locations over a three-month period ending in October.

Phase I of the project was held in August at Eglin Air Force Base, Florida, using Robinson R44 and R66 helicopters, with the R44 flown just over 19 hours and the R66 flown about 15.5 hours.

Phase II was held during September and October at Amedee Army Airfield, California, using a Bell 206L and 407, and an Airbus AS350 AStar and EC130. The 206 logged 15.8 hours, the 407 flew 17 hours, the AS350 logged 16.7 hours and the EC130 reached 22.5 hours (the additional hours came from ferry flights).

“The flight test activity has been a very successful joint effort,” said Michael Watts, NASA acoustic flight test director. “Each partner contributed greatly to the success of the effort through the combined teamwork.”

The FAA portion of the flight tests were contracted to Volpe, which leased the aircraft under an agreement from private operators who provided the pilots and fuel.

These tests were part of NASA’s acoustics research, which is “focusing on low noise for traditional helicopters and going into the emerging markets for non-traditional helicopters, looking at the source noise — how the noise is created, the fundamental physics of that, how that is propagated, what the people on the ground hear, the community noise, and the annoyance and response,” said Susan Gorton, NASA’s Project Manager for Revolutionary Vertical Lift Technology (RVLT). The acoustics research is part of RVLT projects being conducted across three NASA research centers — Langley, Glenn and Ames.
About the Author

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In conducting the tests at Amedee AAF and Eglin AFB, NASA used its mobile acoustics flight facility with wireless microphones, “plus a couple of command trailers,” Gorton said. “We can deploy our equipment and research staff to a location, then test whatever the vehicle of interest is. In this case we were working with the FAA with testing the two phases.”

Data from the 2011 flight test was used to validate the analysis tool for accuracy in predicting noise footprint, Gorton said.

Then the tool was used to predict low noise flight paths for new vehicles, and those vehicles and flight profiles became the subject of the recent test.

Phase II was completed on October 31, with the aircraft being flown at different flight speeds and descent angles, “which are some of the strongest variables,” said Gorton.

One aspect of the tests “was to see if we can come up with a rule of thumb of how to fly helicopters quietly,” Gorton said. “There are different ways to trim helicopters as you fly — left turns may be quieter than right turns, descending faster or slower or at specific angles may be quieter. We want to get those rules of thumb out there to the operators and pilots to help them fly quieter. So, it’s trying to put that research into a form that people can use. In the future, we are looking at how do we give pilots a display that helps them. They need something that helps them, not overloads them.”

Results from the flight tests will be published next year and used to validate and refine the acoustic prediction models, with, of course, the hopes that the data and the models will help to reduce helicopter community noise and noise complaints.