

OEM Perspectives on Noise



How the helicopter manufacturers are responding to the growing public and political outcry about helicopter noise

By Mike Hampson

With communities in New York, Los Angeles and other cities around the world restricting helicopter flights due to noise complaints, we ask five Original Equipment Manufacturers (OEMs) for their perspectives on noise. The threat of legislation to limit helicopter flights is affecting operations and ultimately may affect a reduction in future sales. Here we explore what the OEMs are planning to do about it.

1) Are current model helicopters quieter than past models?

Bell Helicopter: New helicopter designs from Bell are significantly quieter than in the past as federal noise regulations

The MD600N – as well as the MD 520N and MD 902 Explorer – features the NOTAR anti-torque system. (Photo courtesy of MD Helicopters.)

have become more stringent and helicopter pilots have become sensitive to the communities where they operate. The FAA's proposed new Stage 3 noise certification regulation governs three conditions of rotorcraft operation – takeoff, flyover, and approach – with each flight condition required to be below a new, lower maximum noise limit. Bell's current commercial models in production meet the [International Air Transport Association (IATA)] Stage 3 noise limit criteria.

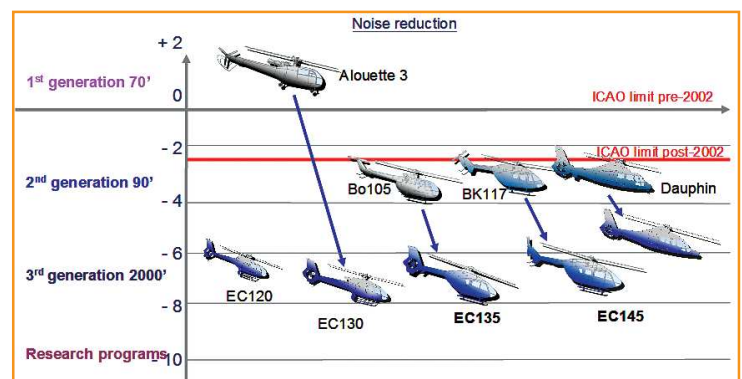
Eurocopter: Current helicopter models are without a doubt quieter than past models. This can be seen in the global

reduction in certification noise levels witnessed on the worldwide fleet. Take the EC145 family of aircraft for example. This helicopter was first certified as the BK117, and it has been continuously improved since. The latest generation [the EC145T2] features a quiet Fenestron anti-torque system, which greatly reduces noise levels and improves the acoustic "feel" of the aircraft. Preliminary noise certification data demonstrate that this increases the cumulative margins with respect to certification limits by 5 dB. This is a substantial noise reduction.

Clean sheet designs are also much



A Bell 407 cruises over the New York skyline. (Photo courtesy of Helicopter Flight Services, HeliNY.com)



As this chart indicates, the noise levels of modern helicopters are significantly lower than previous generations, with research efforts continuing the trend. (Courtesy of Eurocopter.)



Sikorsky notes that current model helicopters like the S-76D have achieved significant noise reductions across the spectrum of test points. (Sikorsky photo by Ned Dawson.)



AgustaWestland's family of new aircraft – (left to right) the AW169, AW139 and AW189 – feature 5-bladed rotors for reduced blade loading and noise generation. (AgustaWestland photo.)

quieter than previous rotorcraft generations. Most manufacturers include challenging low noise objectives in the early phases of the design process and strive to achieve these objectives as the development progresses. Eurocopter's EC175 is a good example: this aircraft incorporates design features that strive for the best compromise between environmental constraints and program objectives. This mainly translates in Eurocopter's most ambitious low-noise rotor RPM scheduling law developed for a serial aircraft to date. The result is a helicopter which is among the quietest in its class, while still achieving exceptional performance and ensuring the highest standards of safety.

MD Helicopters: A social responsibility to positively impact the communities that our operators serve includes improving safety, minimizing noise levels and expanding critical mission performance. Together, these factors ultimately save lives through the success of enforcement and rescue missions while curtailing negative impacts on communities such as overhead noise and mitigating risks to crews and civilians on the ground. Providing reliable, high performance rotorcraft advancements is the enabler to realizing continued improvement in all areas. Proper maintenance and training in "noise smart" and safety operating practices are also integral to diminishing adverse impacts on urban neighbors.

Overall helicopter noise, as experienced by ground observers, is projected from a multitude of sources, with the main rotor and the tail rotor providing the largest contributions.

Studies show that more than 40% of helicopter noise is projected from the tail rotor. The largest advancement in noise reduction for helicopters was through the market introduction of NOTAR (No Tail Rotor) technology in 1990. The measurable result is a 50% improvement in noise versus comparative tail rotor models.

Sikorsky: Yes. New helicopter models are making substantial headway in reducing noise. One of the major challenges has been simultaneously achieving noise reductions for the full spectrum of helicopter operations (cruise, climb, descent, maneuvering and hover flight conditions) given the multiple source noise mechanisms of helicopter rotors. Past designs have often incurred trade-offs between noise levels for different flight regimes, but current model helicopters have been more consistently achieving across the board reductions. The Sikorsky S-76D, with 3 to 4 dB reductions in all three noise certification flight conditions, is a good example of this as one of several recent helicopter models with substantial margins to the certification limits. Competitive forces will continue this trend.

2) What future strategies are you working on to reduce helicopter noise?

AgustaWestland is continuously working on the main sources trying to reduce the noise generated by main rotor and tail rotor using new blade tips, airfoils, tip shapes and reducing tip speed – but without penalizing performance.

Bell Helicopter is employing several strategies to meet reduced noise levels and is actively researching new design techniques for future models. The Bell 525 Relentless will incorporate a new 5-bladed main rotor design with an advanced tip shape to mitigate the impulsive sound characteristic of older designs. No parameter has been found to be more effective in reducing noise than a reduction in rotor tip speed, which is achieved by reducing the rotor rotational speed. The 525 Relentless incorporates a computer-controlled rotor speed strategy that reduces rotor speed during normal operations, yet also maintains adequate rotor speed during critical flight conditions to maximize safety of flight. As has been done for previous Bell models, the 525 Relentless program will explore and test different methods specific to that aircraft to minimize noise and develop recommended flight procedures for flying neighborly. It is anticipated that the Relentless will be quiet enough to meet the next stage of FAA noise regulations expected to be adopted in the next 10 years. A number of research programs specifically designed to further reduce tail rotor noise (a major contributor to the noise signature of lighter helicopters) are also ongoing.

Eurocopter: The strategy regarding external noise is based on three main pillars:

First, it includes mature noise reduction technologies in new and upgraded aircraft. This has resulted in the recent use of the Fenestron on the EC145T2, and on the generalization of



Eurocopter's Fenestron – shown here on the EC145T2 and EC130T2 – has a significant reduction in tail rotor noise in many flight regimes. The experimental X3 removed the tail rotor altogether. (Eurocopter photo by Anthony Pecchi.)

automatic low-RPM modes on their products. These technologies often require significant development work to be implemented on serial aircraft, but they lead to very noticeable results in terms of noise reduction.

Secondly, Eurocopter continues to mature advanced technologies, such as the Blue Edge double-swept planform and Blue Pulse active flap system, both of which have demonstrated significant noise reductions in flight on demonstrator aircraft. The effort required to make a significant impact on perceived noise is often costly and time-consuming, and needs to be part of a mid- to long-term strategy. The modeling and understanding of the complex rotor aerodynamics driving the noise generation is also very important, and the development of new technologies goes hand-in-hand with better physical models.

Thirdly, Eurocopter works with operators and legislators to define the root cause of the complaints, and therefore better identify the priorities in terms of future developments.

Indeed, it has long been known that a complex socio-economic and psycho-acoustic dynamic greatly influences the way people react to helicopter noise. In each of these three points, Eurocopter focuses not only on noise at the source, but also on operational aspects. This includes developing noise abatement procedures and piloting aids to implement them without additional

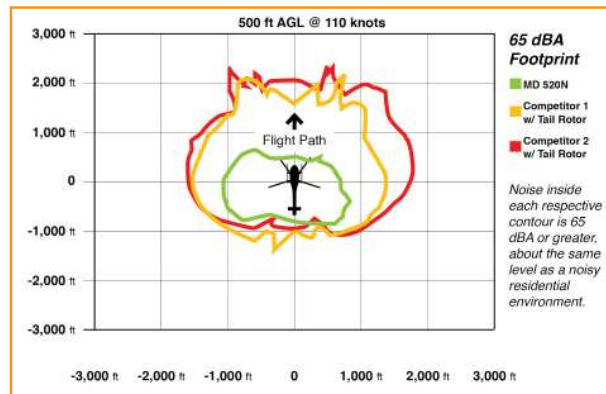
workload, while improving the way they model perceived rotorcraft noise for better land-use planning and flight planning management.

MD Helicopters:

While the large leapfrog that NOTAR technology brings to noise reduction has already been achieved, refinements are currently being evaluated by MD engineering teams. Much of the

opportunity lies in the redesign of the NOTAR fan blades and boom slot design to provide a more efficient aerodynamic design. An enhanced design will translate into additional aerodynamic efficiency versus today's systems. The initial simulations and prototype work are centered on the twin engine MD 902 Explorer, a model popular with air rescue and law enforcement groups performing missions in urban areas.

Main rotor blade design advancements are another major focus to reduce noise. New developments in composite blades on MD aircraft



MD Helicopters comparison of the average noise of a NOTAR vs. tail rotor equipped helicopters. (Courtesy of MD Helicopters.)

incorporate advanced tip designs to help diminish noise. This technology will be applied to both the main rotor blades and tail rotor blades on MD's fleet of single engine aircraft. Testing is ongoing to evaluate the overall improvement in noise signature and flight performance.

Sikorsky: Developing and implementing high performance, low noise rotors is a primary thrust in reducing helicopter noise. In addition to directly addressing source noise mechanisms, these high performance rotors can permit reductions in rotor speeds with significant reductions in noise. Lower and/or multiple rpm helicopters are increasingly becoming the norm, with lower rotor speeds at lower altitudes for reduced noise which can be increased to regain performance at hot and high conditions, for example. Other active and passive rotor noise control technologies are being researched and developed to achieve the next generation of low noise helicopter rotors. Finally, noise abatement flight procedures are a key element in a noise reduction strategy. Establishing flight procedures that avoid peak source noise and/or ground observer noise levels are a cost effective way of reducing helicopter noise impacts for operators.

3) What is your perspective on HAI's "Fly Neighborly" initiative and are you developing procedures for your aircraft?

AgustaWestland is involved in European Union research projects dedicated to reduce the helicopter noise impact on ground. FRIENDCOPTER was a first step in this direction and the company is now also involved in Clean Sky's Green Rotorcraft project. Recently, AgustaWestland, in order to demonstrate the necessity, possibility and capability to develop a helicopter network in Italy for more efficient transportation connections, has dedicated resources to the VERTIPASS program, in which noise impact and emissions have great importance, considering that helicopters have to operate in (or close to) urban areas.

Bell Helicopter: "Fly Neighborly" is an innovative program that Bell Helicopter fully supports and integrates into operations across the company. They are using Fly Neighborly as a model as they return flight operations to their main corporate campus in Fort Worth to ensure that Bell maintains good relationships with area residents and



Bell plans first flight of the 525 Relentless next year. It uses a 5-bladed rotor with advanced airfoils and blade tips for reduced noise. (Bell Helicopter photo.)

municipal leaders.

The "Fly Neighborly" initiative originally proposed by Bell and championed by the Helicopter Association International (HAI) is a recognition that helicopters operate at more conditions than just the three regulatory points, and pilots can play a significant role in how their aircraft will impact specific communities. The "Fly Neighborly" initiative calls for pilots to plan their routes to avoid noise-sensitive areas, fly as high as safely possible while enroute, be aware of and avoid noisier flight conditions, and descend in the quietest method appropriate to their helicopter model.

Bell Helicopter's newest model currently in development, the Bell 525 Relentless, has been designed from the beginning to have a low noise signature as a key feature, incorporating a significantly quieter rotor system than previous models.

Eurocopter: HAI has led numerous noise initiatives, and they are largely to thank for raising awareness of the noise issue in the operator community, as well as for providing basic guidance and training to the pilots. The Fly Neighborly Guide is a step in the right direction, giving general guidelines to pilots which can help in reducing their impact on surrounding populations. However, more can be done in this area, especially since research has shown that noise abatement procedures should be targeted to a specific operating site and helicopter model.

Operating regulations and weather conditions also should be taken into

account in the development of these procedures. This means that in order for these procedures to be truly accepted by the operator and pilot community, dedicated piloting guidance and training means should be developed. Only then will we really be able to materialize the large potential impact that these procedures can have on improving community acceptance.

Eurocopter recently successfully demonstrated new landing procedures relying on augmented satellite guidance. These new landing procedures were validated with an EC155 during flight tests performed as part of Green Rotorcraft (see "Industry Briefs," *Vertiflite*, Sep-Oct 2013). The flights demonstrated significant reductions in noise footprint, consistent with predictions. They also confirmed that such automated low-noise approaches could be tailored to local environmental requirements, thereby optimizing operations for the most sensitive environments.

Sikorsky has developed and provided noise abatement flight procedures for Sikorsky helicopter models currently in the fleet and will continue to do so for upcoming models including the S-76D helicopter as it enters the marketplace. Sikorsky was also an instigator and collaborator in the development of the HAI Noise Abatement Training Program distributed online.

4) Have you implemented any public relation strategies related to noise?

AgustaWestland: VERTIPASS is a good opportunity to publicize and to inform the general public of the capabilities of

this means of transportation, especially trying to reduce the common perception of helicopters as dangerous and noisy transports. The next world's fair, Expo 2015, will be held in Milan and helicopters are expected to play an important role in the mobility aspect.

European Union research projects are not only dedicated to the technical aspects, but human aspects and reactions to helicopter noise are taken into consideration as well. Dissemination of the results to the public is very important. It is also important to the helicopter manufacturers that reactions or decisions by the public are not based on wrong information, but rather have a solid technical basis. These promotional activities will be beneficial to enhance the reputation of the rotorcraft, reflecting the quantum leap forward in recent years through advanced technology.

Eurocopter strongly believes in transparent environmental communication. It is important for the public and the legislators to be aware of the considerable effort the industry is



A Sikorsky S-76A takes off from Vancouver to Victoria. Helijet varies the routes of its 176 weekly scheduled flights and works with the communities to address noise concerns. (AHS International photo.)



An AW139 flies at Fieramilano, the future site of Expo 2015, the world's next Universal Exposition. (AgustaWestland photo.)



Eurocopter flight tested the Blue Edge blade on an EC155 Demonstrator in 2007. The approach reduces noise generated from Blade-Vortex Interaction. (Eurocopter photo.)

putting into developing noise reduction technologies. It is equally important to understand the complexity of rotorcraft noise generation and propagation, and to highlight the need for further basic research on this topic.

However, Eurocopter realizes that much remains to be done to improve community acceptance, which is why noise reduction remains a key objective in any new development. The industry therefore needs to adapt its communication so that its noise reduction efforts are understood by the public. With that goal in mind, Eurocopter proposed in 2010 a rating scale to simplify the presentation of noise and emission levels. AHS subsequently sponsored a working group which refined the definitions of these ratings. Eurocopter modified its rating scale according to its recommendations.

5) What recommendations do you have for helicopter pilots and operators or do you have a public relations strategy that helicopter operators can use?

AgustaWestland pays great attention



Eurocopter's Blue Pulse active rotor, using piezo-driven flaps on the trailing edge, reduces both external noise and passenger vibrations. Eurocopter began flights in 2005, showing a noise reduction of up to 5 dB. Other manufacturers have ground tested active flaps. (Eurocopter photo)

to public opinion about noise impact. AgustaWestland is committed to develop new technologies which can enable customers and operators to meet future standards supporting them with required information and suggesting the capabilities of its helicopters to perform trajectories with lower noise impact. AgustaWestland flight manuals will include not only the required certification values but also noise level values achievable using a certain procedure and/or trajectory, in particular during the approach/takeoff phases.

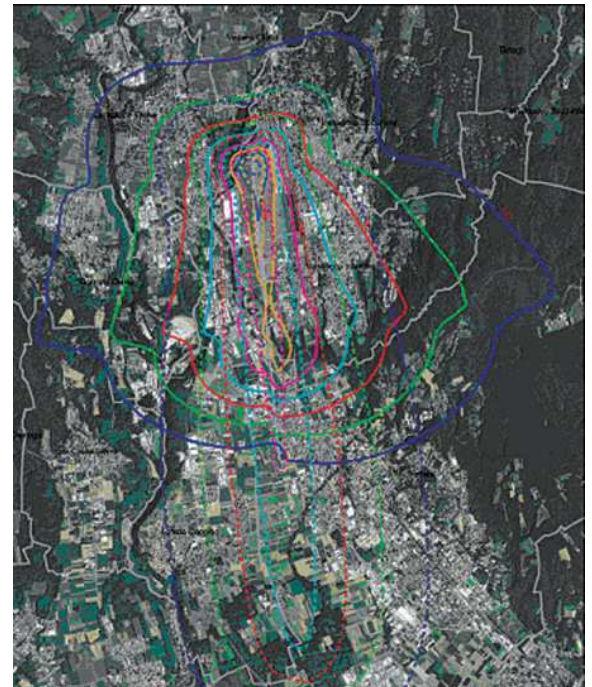
Clean Sky's Green Rotorcraft research project includes many work packages dedicated to noise footprint reduction through operations. It includes defining standards to design low-noise departure and approach procedures, improving pilot awareness during the execution of low-noise procedures using advanced displays and dedicated guidance means, and improving on-board mission planning capability considering noise on ground.

Bell Helicopter recommends all operators take advantage of the resources in the Fly



Neighorly program, which has extensive ideas on communications strategies. The most important thing to remember is to be accessible and address any public concerns that arise – do not ignore concerns or assume they will go away.

Eurocopter: Operators should work closely with local legislators and



Results obtained using experimental data and the Integrated Noise Model are shown in the figure, comparing a 3° and a 9° approach. The same colored line means the same noise level.



London Air Ambulance's single MD902 Explorer flies 275 missions a month over London. The pilots fly "noise-smart" operations. (Photo by Simon Lamrock of Lamrock Images.)

community groups, and should listen closely to the complaints that come their way. Often, simple steps can be implemented to improve the situation. They believe the OEMs should also work more closely with the operators, in order to assist them in putting in place noise abatement programs. Indeed, the manufacturers have an in-depth knowledge of the noise characteristics of their aircraft, but often do not quite know what drives the public's negative reactions in specific conditions. A closer link between manufacturers and operators would ensure that the latest technologies and knowledge would be used to their full potential.

MD Helicopters: The adoption of "noise-smart" operating practices by pilots is prevalent among MD operators. One benchmark example is London Air Ambulance, a long time operator of the MD 902 Explorer. Based at the Royal London Hospital and founded in 1989, the nonprofit service utilizes its helicopter only during daylight hours, to minimize impact on neighbors. In the average month the group performs more than 275 missions throughout London, a prime example of positive urban integration. Overall, the group has performed more than 28,000 critical missions to support local and neighboring communities of London.



Like the Bell 525, the new Short Light Single (SLS) is being designed to meet IATA Stage 4 noise targets. (Bell Helicopter graphic.)



A Sikorsky S-92, which uses swept tips like the Black Hawk, flies over Los Angeles, where community complaints have risen in recent years. (Sikorsky photo.)

Sikorsky: Understanding and appreciating local community noise issues are key to establishing better relations. Training and implementation of noise abatement flight procedures and routes is the most effective way to reduce community noise issues. Many operators do implement Fly Neighborly programs in their operations and a key element in successful implementation is often simply communicating what is being done to reduce noise impacts and why.

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About the Author

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In recognition of the significance of noise complaints and the complexity of resolving the helicopter noise issue, AHS International has initiated an effort to help the technical and regulatory community better understand and address helicopter noise and noise complaints. The rotorcraft manufacturers have addressed the industry efforts regarding noise in this article, but more needs to be understood regarding the psycho-acoustics aspect of community response to noise. Go to www.vtol.org/noise to learn more about AHS's efforts and resources on this important effort. This article is one in a series addressing rotorcraft noise.