U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: NOISE ABATEMENT FOR HELICOPTERS

Date: 6/4/87

Initiated by: AFS-840

AC No: 91-66

Change:

1. PURPOSE. This advisory circular (AC) presents guidelines intended to assist pilots, operators, managers, and other interested persons in the establishment of effective noise reduction procedures when operating helicopters. It is by no means totally comprehensive. However, when the flight procedures and concepts outlined herein are followed, significant noise abatement will be achieved, and public acceptance of helicopter operations should be enhanced in noise-sensitive areas.

2. RELATED READING MATERIAL.

a. AC 91-36C, VFR Flight Near Noise-Sensitive Areas.

b. AC 150/5020-1, Noise Control and Compatibility Planning for Airports.

c. AC 150/5020-2, Noise Assessment Guidelines for New Heliports.

The above Advisory Circulars are free and available from the U.S. Department of Transportation, Utilization and Storage Section, M-443.2, Washington, DC 20590

d. Fly Neighborly Guide, published by the Helicopter Association International, 1919 Duke Street, Alexandria, VA 22314; (703) 683-4646. This publication is free except for postage.

e. Federal Aviation Regulations (FAR) Part 150. (For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

f. The FAA Office of Environment and Energy has issued technical reports containing helicopter noise measurement/flight test data. These data reports are compiled for some specific types of helicopters. The Office of Environment and Energy also has published FAA-EE-85-2, Aviation Noise Effects. (Contact National Technical Information Service (NTIS), Springfield, VA 22161, or FAA Office of Environment and Energy, Noise Abatement Division, AEE-100, 800 Independence Avenue, SW, Washington, DC 20591.)

3. BACKGROUND.

a. The Federal Aviation Administration (FAA) continually receives complaints concerning low flying aircraft over noise-sensitive areas. These complaints have prompted requests for regulatory action which would prohibit low altitude flight over certain identified noise-sensitive locations.

b. FAR Part 36, as adopted in 1969, does not address rules applicable to helicopters identified herein. However, since 1969 the FAA has considered adopting existing noise standards for aircraft that would affect the operation of all helicopters. After careful evaluation of the economic impact the considered proposals would have on helicopters, these proposals were withdrawn. The FAA has continued to actively study the issues surrounding noise abatement in connection with the certification and operation of helicopters and to compile technical data on noise abatement in an effort to reach an equitable solution to the acoustical impact on the public.

4. OPERATIONAL CONSIDERATIONS.

a. Operator/Pilot Responsibilities. One of the greatest challenges facing the helicopter industry is gaining public acceptance of the helicopter. The helicopter is considered anti-social by some segments of the public. In many cases, acceptance of helicopter operations is thwarted by an angry, sometimes uninformed community who fear the perceived noise and safety problems inherent with helicopters. Public reaction to a noise environment depends upon many complex physical, economic, and psychological factors. Therefore, it is up to the operator to educate the public about the safety and usefulness of the helicopter and to equip the aircraft with sound-suppressing devices when they are available and needed. The pilot can make the public less hostile to the helicopter's day-to-day operations by being aware of noise-sensitive routes and areas and by flying the helicopter in such a way that the sound of the aircraft causes the least possible annoyance to the public.

b. The Source of Noise. The acoustical impact of a helicopter is a function of the size and the type of powerplant used as well as the movement of the rotor blades through the atmosphere as they produce lift. Turbine-powered helicopters are generally quieter than piston-powered helicopters with muffled engine exhausts. Turbine-powered helicopters produce sounds often no louder than familiar surface transportation vehicles. The acoustical signature or sound of a helicopter is also due in part to the modulation of sound by the relatively slow-turning main rotor system. This modulation attracts attention much as a flashing light attracts attention by being more conspicuous than a steady one. The modulated sound is often referred to as blade slap. For a typical helicopter, blade slap occurs during partial power descents or when a blade intersects its own vortex system or that of another blade. When this happens, the blade experiences rapid changes in angle of attack. Either or both phenomenon generates sound. Blade slap is also generated during high speed level flight due to a shock formation being created on the advancing blade tip. This mode of flight should be avoided. This alone is an effective noise abatement operating procedure in populated (noise-sensitive) areas. Figures 1 and 2 display typical noisy flight operational areas for light and medium weight helicopters. Perceptible, continuous, and maximum slap areas should be avoided by the conscientious airman. One method would be to reduce airspeed 10 to 20 percent below normal cruising speeds.

FIGURE 1. MAIN ROTOR BLADE SLAP BOUNDARY--TYPICAL LIGHT HELICOPTER

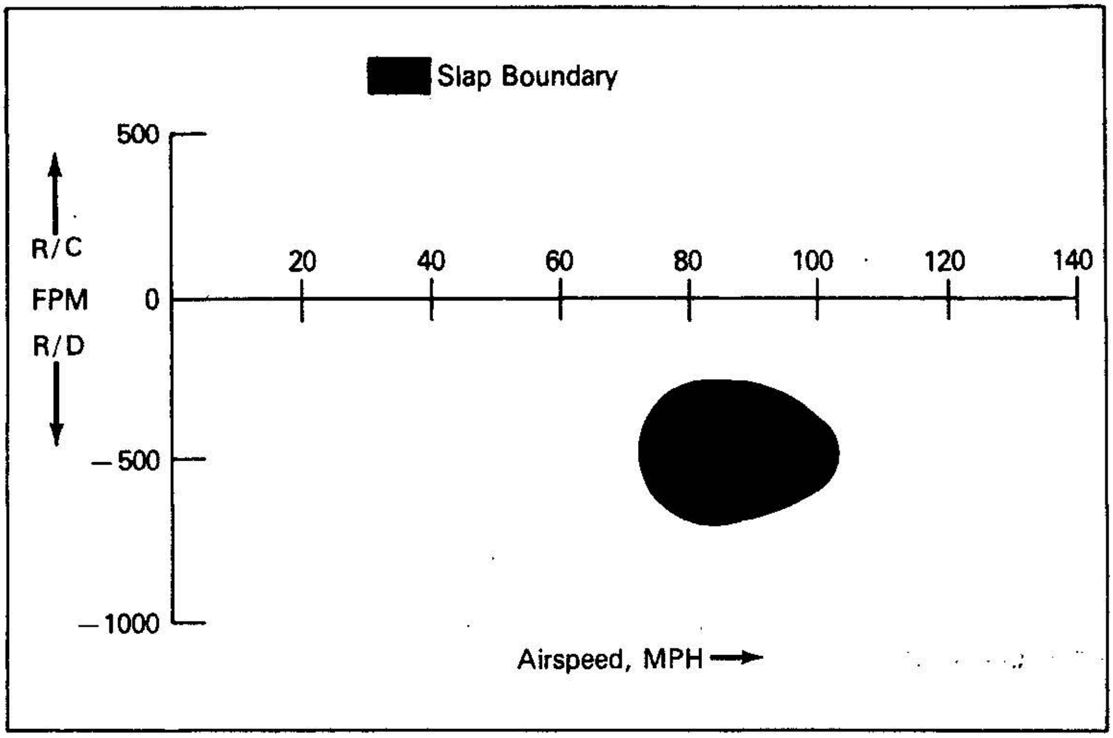
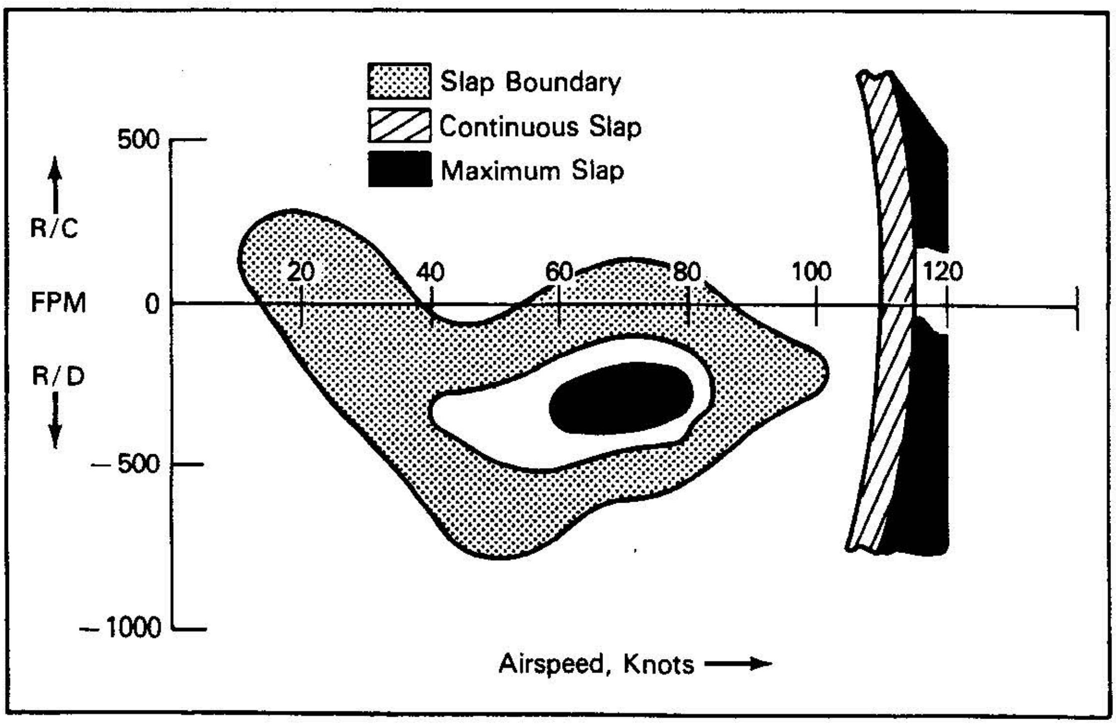


FIGURE 2. NOISY FLIGHT OPERATIONS--TYPICAL MEDIUM HELICOPTER



c. Sound Measurement. Numerous methods are used to determine the intensity of sound.

(1) Sound levels in the community are often expressed using a unit called the A-weighted sound level. The term "weighted" refers to the filtering or weighting of sound to simulate the response on the human ear. Since high frequency sound is more readily perceived than low frequency sound, this unit of measurement filters or weights the sound and considers how the human ear responds to combinations of different pitch. The A-weighted sound level is referred to as dBA or by the more recent term, ALm.

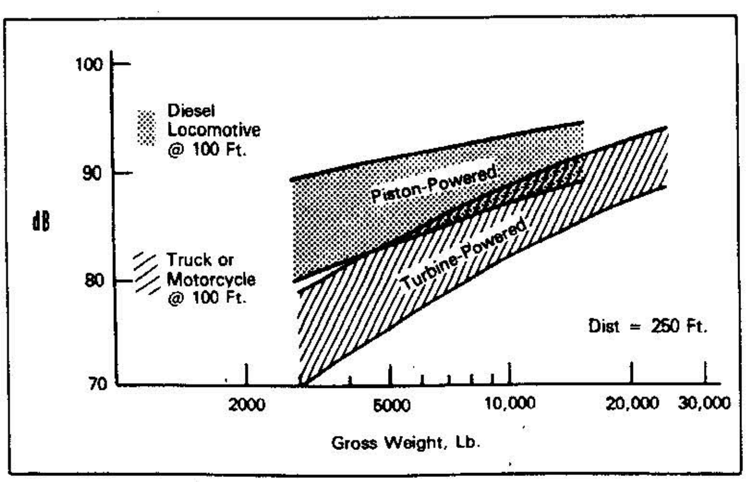
(2) Sound exposure level (SEL) is a measurement of the total amount of the sound energy (duration and magnitude) from a single event and expressed in decibels (dB). The sound exposure level is A-weighted and is used in calculating the helicopter noise contribution to the equivalent sound level (Leq) and the day-night sound level (DNL).

(3) The average sum of all noise events for a given period of time is called equivalent sound level or Leq. The word equivalent is used so that a fluctuation sound level during a specified period of time can be compared to a steady sound level for the same period of time. The purpose of Leq is to provide a single number value noise measurement of community noise exposure over a specific period of time.

(4) The day-night sound level (DNL), is also expressed in dB. It is the sum of sound exposure for a given period but considers night penalties for increased annoyance factors of a community. It is similar to Leq, the main difference being a 10 dB correction factor which is applied to nighttime (10 p.m. to 7 a.m.) sound levels to account for increased annoyance during the night hours. The day-night sound level was introduced as a simple method for predicting the effects on a population of the average long-term exposure to environmental noise. It can be derived directly from the A-weighted sound level.

(5) Figure 3 depicts measured noise levels expressed in dB as compared to some ground vehicles.

FIGURE 3. TREND OF HELICOPTER NOISE LEVELS IN dB
(These levels are not A-weighted, averaged, or otherwise corrected.)



d. Meteorological conditions have a bearing on helicopter noise. A pilot may be able to adjust his flight schedule to take advantage of such conditions when noticeable. Wind carries sound in the direction toward which it is blowing and makes a background noise of its own which tends to lower the surface annoyance factor of helicopter noise. In some parts of the world, the wind directions are predictable on a near-daily basis. When pilots are aware of the surface wind direction and velocity, helicopters should be less objectionable when flight operations are conducted downwind of populated or noise-sensitive areas. The direct effect of humidity on sound propagation is of little importance, other than the attenuation of high frequency sound. Humidity, in the form of visible moisture in the air (fog, drizzle, light snow), should be used by the pilot as an indicator that the wind gradient is small, resulting in increased sound propagation. Low-wind, high-humidity conditions warrant the use of noise abatement procedures.

5. OPERATING MORE QUIETLY

a. Recognize noise-sensitive areas and avoid them by flying as high as practical. Sound attenuates relative to the square of the distance to the receiver. If the altitude is doubled, the sound reaching the surface is a fraction of what it was. Increasing altitude is probably the most effective means of noise abatement. Low flying creates the worst problems even though the sound footprint is smaller. Avoiding these areas by a lateral offset of 1,000 feet or more in conjunction with the higher altitude adjustment will reduce or possibly eliminate noise complaints. An increased number of exposures to noise sensitive areas will increase the Leq.

b. Noisiest approaches occur in the 55- to 65-knot airspeed range and at a 400- to 600-foot per minute rate of descent. Pilot actions which can be taken to avoid most of this type of noise include:

(1) When practical, leave the last 1,000 feet of altitude at 10 to 15 knots higher airspeed than normal.

(2) Keep rotor torque as low as practicable, consistent with safety.

(3) Tune out main rotor blade-slap impulses with cyclic and collective by operating at airspeeds and rates of descent that keep the aircraft outside of areas that are identified as areas that produce blade slap.

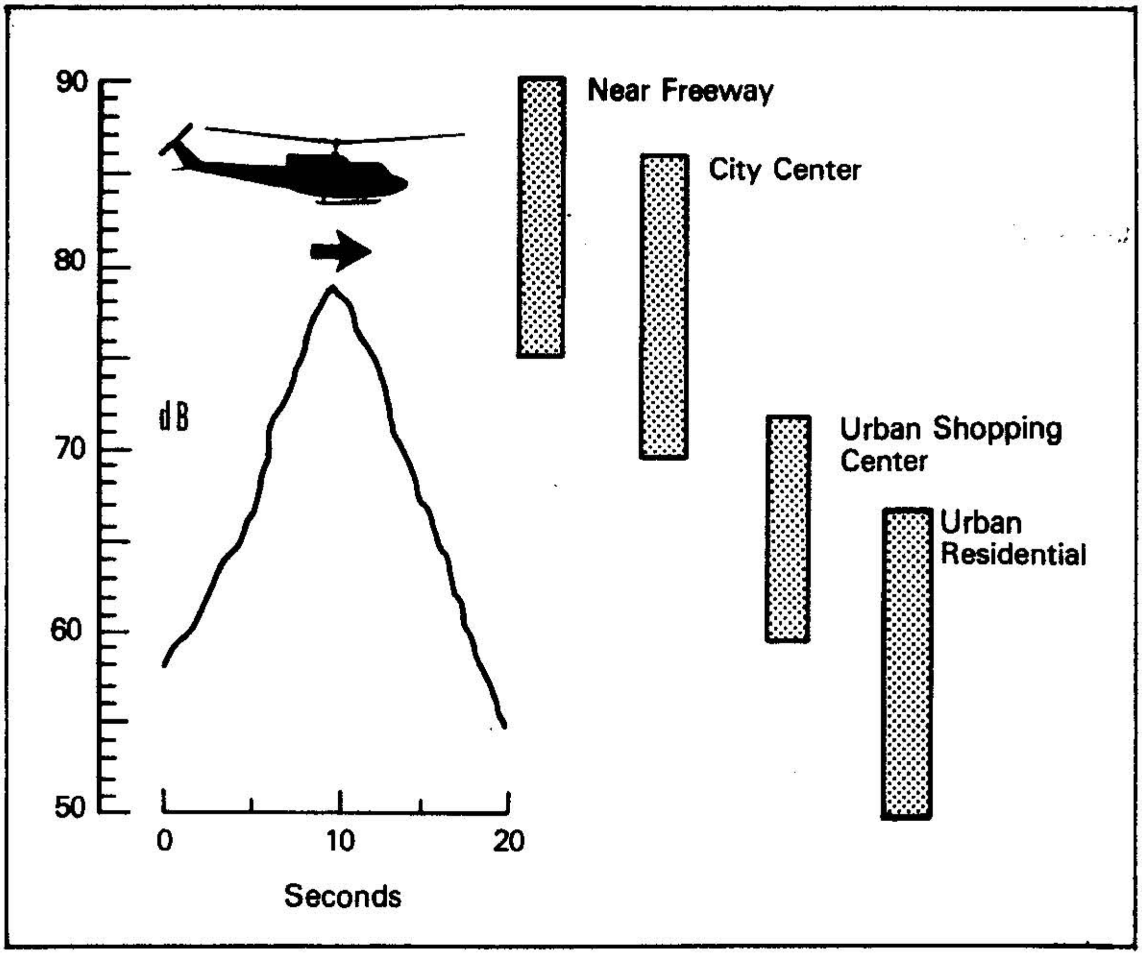
(4) Use sound abatement flight techniques when they have been identified as being quieter for conducting approaches.

c. Noise created by the helicopter when operating at a hover or on the ground can be directed away from the populace by turning the quietest quadrant in the direction of congestion. Noise directional angles can be determined by very simply walking around the helicopter when it is operating and identifying the quietest quadrant.

d. Landings on grass or dirt areas are better than hard surfaces such as concrete. The soft path over which sound travels reduces sound levels.

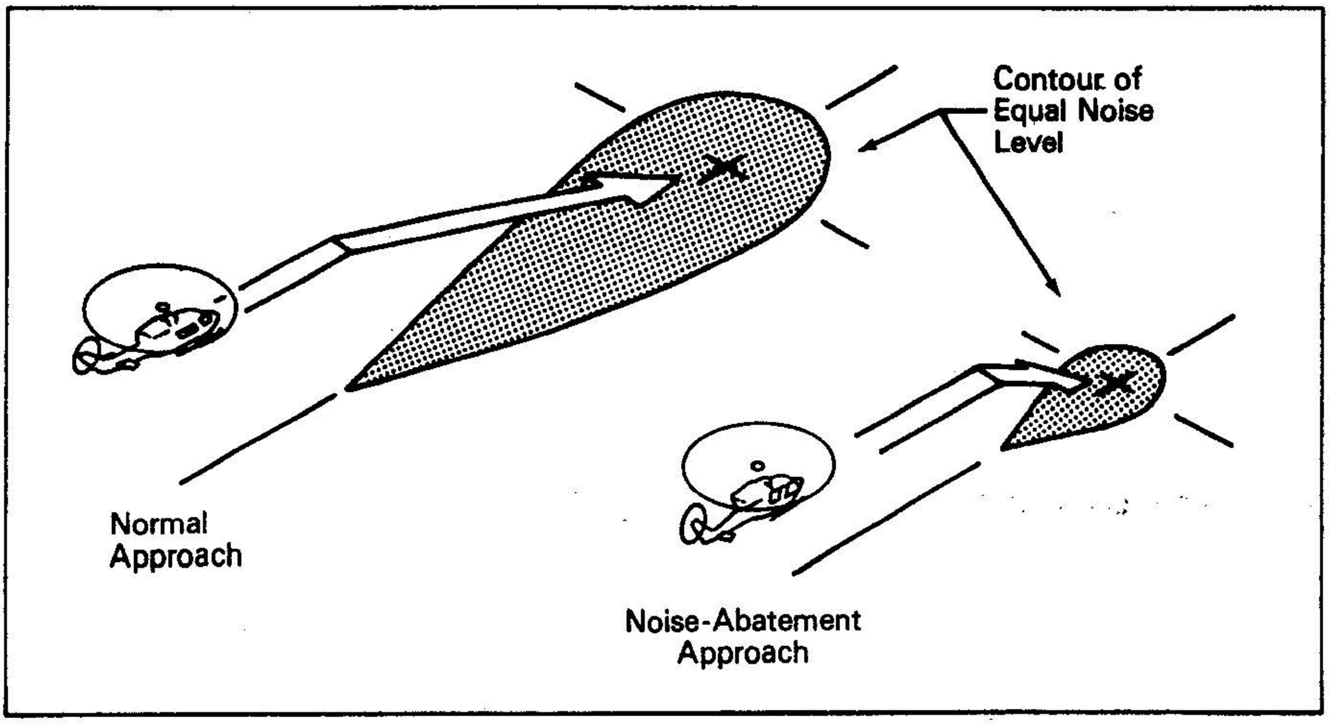
e. Ambient noise is a composite of sounds from many sources (automobiles, trucks, buses, motorcycles, construction noise, aircraft, etc.) within an area and continually varies with time as a result of different levels of activity. This activity changes with the time of day, day of the week, and the seasons. An example of an option available to a pilot would be the use of a freeway route. This would keep the aircraft noise over a high ambient noise area which would cause less of a sound contrast. This would result, in most cases, in less annoyance to the residents below. A depiction of relative ambient noise levels is shown on the chart below.

FIGURE 4. AMBIENT NOISE (Not corrected or weighted)



f. The noise footprint of a helicopter is described as a ground contour of equal sound levels and is relative to the ambient noise level that exists on the surface over which the aircraft is operated. Pilots should consider this factor when planning a flight over noise-sensitive areas. The ground noise exposure footprint contour can be reduced considerably as depicted in figure 5 by using the noise abatement approach procedure. When the footprint is small and a waterway is an available route, it often will absorb the worst noise.

FIGURE 5. SURFACE NOISE - EXPOSURE FOOTPRINT



g. Most helicopter manufacturers today publish noise abatement procedures as a supplement to their flight manual for each specific helicopter. Such procedures normally are categorized as General, Takeoff, Static, Enroute, and Approach and describe the manner in which pilots can operate their specific helicopter in the quietest way. Additionally, most manufacturers have an acoustics department that studies the noise impact of each make and model. Operators are encouraged to make contact with these departments in order to keep their knowledge current on specific methods of noise abatement and to continue efforts to reduce public noise complaints.

h. Aircraft design is a factor under constant review as it pertains to more efficient noise reduction. Manufacturers have made major advancements in aircraft and rotor system designs. However, aircraft and rotor systems cannot be modified to eliminate objectionable noise totally. Helicopter noise intensity is directly proportional to helicopter weight. While the number of main rotor blades may change the frequency of noise, the perceived noise itself will remain basically the same.

6. STATIC MODES. Static operational modes for the helicopter can often be adjusted to reduce noise.

a. If the aircraft is equipped with a piston engine and exhaust pipes that direct exhaust gasses in a rearward direction, noise will be greater to the rear of the helicopter. When operating in areas where there are large groups of people, the aircraft could be parked with the rear of the helicopter pointed in a direction away from them. If you have otherwise determined that one quadrant is noisier than another, the quieter one should be pointed toward the crowd.

b. If an airman intends to park a helicopter at a specific location for a long period of time with the engine running (rotors turning), noise could be reduced by reducing engine and rotor RPM from normal operating RPM to a reduced speed or to ground idle. The approved flight manual or operator's manual should be consulted to assure that there are no restrictions to prolonged reduced RPM operation. Transmission or engine oil pressure minimum values must be observed.

7. BENEFITS. The benefits of quiet operations are unlimited to pilots and those on the surface as well. Some of them are:

a. The need for noise-related regulations is reduced.

b. The helicopter as a business tool would be more acceptable to a community where noise is most objectionable.

c. Point-to-point public transportation would be improved.

d. Police, fire, public safety, and medical services would be enhanced, and lives would be saved.

e. Auto traffic may be re-routed over more desirable routes during peak rush hours because of radio station helicopter traffic reports.

f. Television news crews may bring the newsworthy activities for public view more rapidly.

g. Public acceptance of helicopters eventually would result in an increased number of aircraft available to a community in the event of a natural disaster.

8. PLANS AND POLICIES. The FAA encourages compliance with the good neighbor policies established by professional helicopter associations concerning helicopter sound. Discussions of policy objectives are encouraged throughout the industry to continue efforts to make helicopter sound less objectionable. The FAA is continuing work to develop a heliport noise model. More work is being done to quantify noise. Standard protocol is being developed for noise measurement along normal helicopter approach paths. Additional noise abatement operational procedures will result from these studies, which will be made public upon completion.

William T. Brennan
Acting Director of Flight Standards