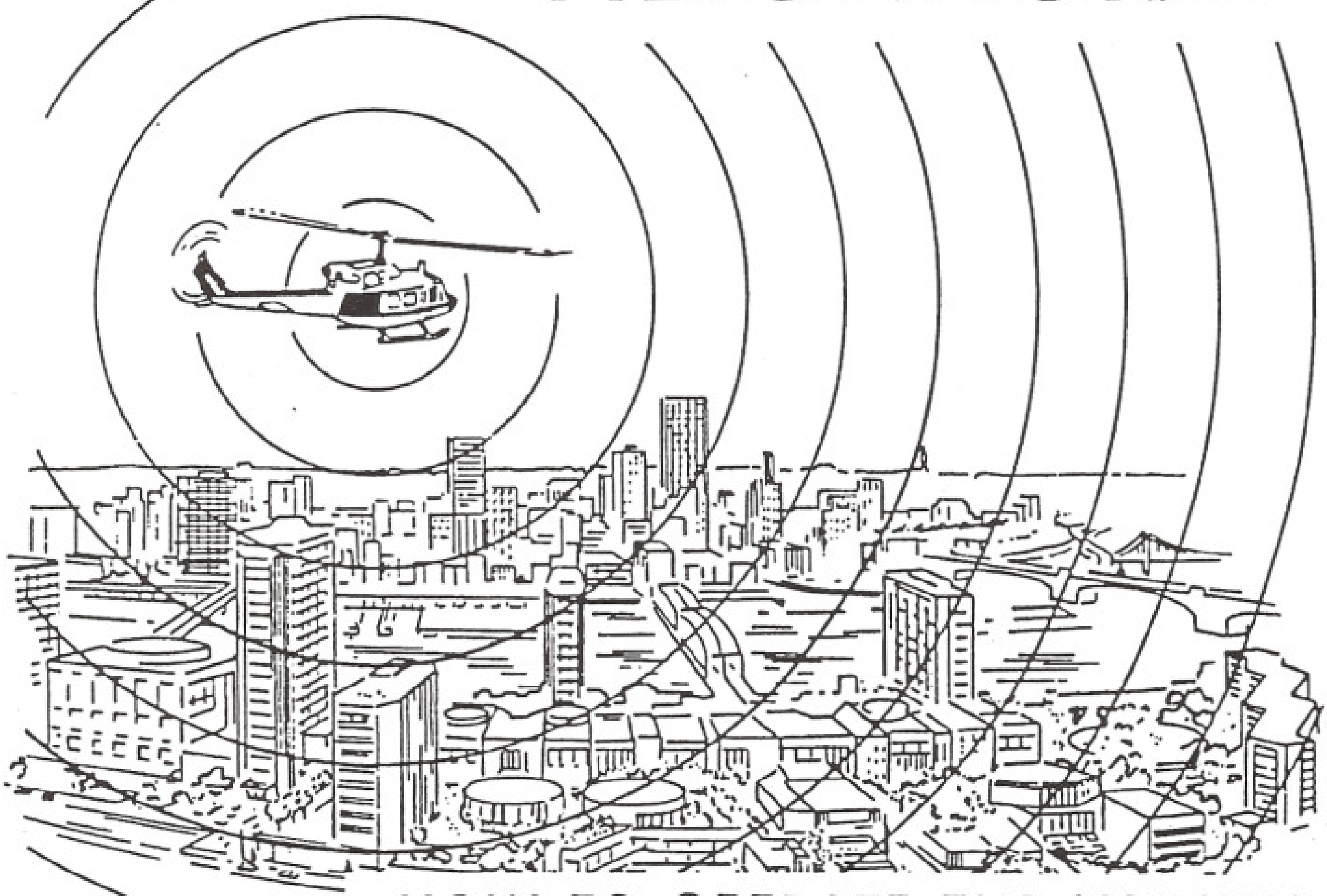
FLYING NEIGHBORLY



HOW TO OPERATE THE MEDIUM HELICOPTER MORE QUIETLY

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When you start operating a medium helicopter in new territory, you add a new spectrum of sound to the usual noise environment. If that territory is a municipality, thousands of people will hear the new sounds and know where they are coming from. How they will react depends upon many complex physical, economic, and psychological factors, but one thing is certain: They will react strongly, adversely, and actively if the sound is too irritating, if it represents something that seems to threaten their safety and well-being, or if they cannot see how the noisemaker benefits them. Although it is up to the operator to educate the public about the safety and usefulness of the helicopter, the pilot can make the public less hostile to the helicopter by flying in such a way as to make the sound of his aircraft as unirritating as possible.

Figure 1 shows the trend of helicopter noise levels and where the medium helicopter (5000 to 12,000 pounds gross weight) fits into the overall noise picture. The units of the vertical scale represent, to some extent, the degree to which a sound will annoy the average human listener. We can't say what sound level will make the housewife, school teacher, or hospital pitient complain to the authorities. Instead, we show on the figure the sound level of a diesel locomotive and a truck or motorcycle. You can compare this with the sound of the helicopter and draw your own conclusions.

Notice that the noise level of a turbine-powered helicopter at a given gross weight covers a range. This is true not only for these helicopters in general, but also for a particular helicopter--the particular one you may find yourself flying, for example. What you need to know is how you can fly that helicopter, given a certain gross weight, in the lower portion of this range of sound levels--at least when you are flying near people whom noise might bother. This write-up tells you about the conditions which produce the higher noise levels during the operation of medium turbine-powered helicopters such as Bell Models 204B, 205A, and 212, and describes flight techniques which will help you to avoid them. A companion write-up contains similar information for light helicopters.

FLIGHT CONDITIONS ASSOCIATED WITH ABOVE-NORMAL NOISE

The unique acoustical signature of the medium helicopter is partly due to the modulation of sound by the relatively show-turning main rotor. This modulation attracts attention, much as a flashing light is more conspicuous than a steady one. The modulated sound is often referred to as "blade slap." Blade slap occurs during high-speed forward flight when a main rotor blade enters the compressible-flow region on the advancing-blade side. Shock waves make the blade's airloads fluctuate, often quite rapidly, and these fluctuations generate noise. For a typical medium helicopter, this occurs at airspeeds above about 100 knots. Blade slap can also occur at lower speeds, when a blade intersects its own vortex system or that of another blade. When this happens, the blade experiences locally high velocities and rapid angle-of-attack changes. This can momentarily drive a portion of the blade into compressibility and possibly chock stall, both of which produce aerodynamic loading variations. Either or both mechanisms generate noise. This can occur in low-speed level flight, during partial power descents, and in turns. Figures 2 and 3 show where you can expect Models 204B, 205A, and 212 to get noisy, giving blade slap regions as functions of airspeed, rate-of-climb (R/C), rate-of-descent (R/D), and g loading during turns.

Low-Speed Level Flight and Partial Power Descents

In low-speed level flight, the main rotor slaps to some degree at airspeeds between 10 and about 85 knots. The worst condition is between about 60 and 80 knots, where the rotor slaps almost continuously. At other airspeeds, it slaps intermittently, an action which can be triggered by wind gusts and by transitioning from slight climbs to descents.

Maximum blade slap occurs during partial power descents--at airspeeds between 60 and 80 knots and rates-of-descent between 200 and 400 fpm. (Engine torque pressure usually varies from 10 to 25 psi.) This slap is caused by the blade interacting with the wake. Although the noise produced at these descent rates is not extremely loud to crew members inside the helicopter, they can recognize it easily and define the "slap boundaries" for their particular helicopter. Of course, people on the ground hear slap increase in intensity as the helicopter descends.

Cruise Airspeeds

At airspeeds above about 100 knots, blade slap intensifies and sounds louder to the people on the ground than does that of any other flight condition of the medium helicopter. Unfortunately, the crew members do not hear it so, because this blade slap propagates forward of the helicopter (primarily) instead of spreading spherically.

Maneuvers

Blade slap also occurs during constant speed turns if turn rates are too high. Here the main rotor blade and wake interact in much the same manner as in partial power descents. As Figure 3 shows, continuous slap occurs in turns which exceed 1.5g with airspeeds between 50 and 90 knots in a left turn and between 40 and 110 knots in a right turn. There is little difference in the intensity of the noise in right or left turns once the cricitcal g is reached. The crew can hear this sound easily.

HOW TO MINIMIZE NOISE

In general, you can eliminate the most offensive noise of the 204B, 205A, and 212 helicopters by keeping them out of the slap regions shown in Figures 2 and 3. This is not always possible, of course, and when the slap regions cannot be avoided, they should be flown through as quickly as possible. There are also other methods of reducing helicopter noise, and you should use them when you can, whether you are flying in a slap regime or not.

Routes and Airspeeds

1. Fly at highest practical altitude during approach to metropolitan areas.

2. Select route into terminal over least populated area.

3. Follow major thoroughfares or railway roadbeds.

4. Do not exceed 110 knots when within five miles of suburban areas.

5. Within three miles of densely populated areas, maintain a cruise speed of approximately 100 knots and reduce rpm to the minimum allowed by the Flight Manual of the particular helicopter.

6. Select the final approach route with due regard to the type of neighborhood surrounding the terminal and the neighborhood's sensitivity to noise. Assess this sensitivity beforehand for each terminal. Some of the guidelines are:

   a. Approach keeping the terminal between the helicopter and the most noise-sensitive building or area.

   b. If the terminal is surrounded by noise-sensitive areas, approach at the steepest practical glide slope.

   c. Avoid flying low near hospitals, nursing homes, schools, residential areas, and other highly noise-sensitive facilities and areas.

   d. If the terminal is in or near a noise-sensitive area, use the noise-abatement approach and landing technique described below and illustrated in Figure 4.

Noise-Abatement Approach and Landing

1. When commencing approach, begin descent at least 200 fpm <u>before</u> reducing airspeed, then reduce airspeed while increasing rate-of-descent to about 800 fpm.

2. At a convenient airspeed between 50 and 80 knots, set up approach glide slope while maintaining the 800-fpm rate-of-descent.

3. Increase rate-of-descent if the main rotor tends to slap, or if a steeper glide slope is desired.

4. Approaching the flare, reduce airspeed to below 50 knots before decreasing rate-of-descent.

5. Execute normal flare and landing, decreasing rate-of-descent and airspeed appropriately.

The basic difference between this quieter approach technique and normal operation is that the pilot begins his descent before reducing airspeed. Both procedures give approximately the same airspeed during the approach, with the qieter technique using a glide slope which is a few degrees steeper. Once the pilot has transitioned from cruise to the approach glide slope, he can tailor his airspeed and rate of descent to fit local conditions, avoid unsafe regimes, and still guarantee minimum noise. This noise-abatement flight technioue reduces the ground area exposed to a given noise level by as much as 80 percent. Figure 5 shows this for a conventional straight-in approach.

Departure

Takeoffs are reasonably quiet operations, but you can limit the total ground area exposed to helicopter sound by using a high rate-of-climb and making a very smooth transition to forward flight. Your departure route should take you over areas which are least sensitive to noise.

Maneuvers

Avoid rapid, high g turns, as a general rule. When the flight operation requires turns, perform them smoothly. Be smooth in all other maneuvers, also.

METEROLOGICAL CONSIDERATIONS

Although the pilot cannot control the weather, he may be able to adapt his flight schedule to take advantage of meterological conditions which can help him to minimize noise. The two weather factors which are most useful in this respect are wind and temperature. They are helpful because they vary throughout the day (diurnally) in a more-or-less predictable manner, and affect the propagation of sound.

Wind has two effects on sound. It carries it in the direction toward which it is blowing, and it makes a background noise of its own which, in high winds, tends to reduce the annoyance factor of the sound of a helicopter. In inland areas, surface winds generally are stronger during the daytime (maximum in midafternoon) and weaker at night. In coastal regions, land and sea breezes (caused by the tendency of land to heat and cool more rapidly than water) give a different diurnal pattern, beginning to blow shortly after sunrise (sea breeze) and sunset (land breeze). You can use these winds to increase the acceptability of your helicopter by flying downwind of densely populated areas and by scheduling after noon the majority of flights near especially noise-sensitive areas.

Temperature likewise has two effects upon sound. One is the tendency of warm air to be more turbulent than cold air and to disperse sound with more loss in intensity (even though the sound wave actually travels somewhat faster in warm air than in cold). The major effect of temperature depends upon the temperature gradient--the change in temperature with altitude. The normal gradient is negative--temperature decreasing with altitude. Because sound travels faster in warmer air, in atmosphere with the normal gradient the lower part of a sound wave tends to outrun the upper part, making the propagation, in effect, curve upward and away from the populace. This negative gradient reaches a maximum in the late morning or just after noon, and increases in magnitude during summer months moreso than on wintry days. This means that it is of some value to schedule flights to and from noise-sensitive areas during the warmer parts of the day.

At certain times, however, there may be an inversion in the atmosphere--a layer of air from a few hundred to a few thousand feet thick in which the temperature increases with altitude. The inversion reverses the normal "curvature" of sound propagation, turning an abnormally high portion of the sound energy back toward the ground. The most severe inversions usually occur at night and in the early morning. These, then, are the times when the sound of the helicopter will have the most adverse effect upon people on the ground.

A third meterological item that affects the propagation of sound is humidity. But its direct effect is of little importance (it attenuates high frequency portions of the sound spectrum). As visible moisture, it is important as an indicator, in that on overcast days of fog, drizzle, or light snow, temperature and wind gradients are generally small, resulting in increased sound propagation. Of all the many combinations of atmospheric conditions, that which does least to reduce the sound of a passing helicopter is the combination of no wind and an overcast on a cold morning. It is most important that at these times you use the noise-abatement flight techniques.

Although environment is hardly a meterological subject, it might be well to mention here that the ground environment has much to do with the offensiveness or lack of offensiveness of the sound you make. The background noise level or sound environment of residential areas reaches its lowest point between late evening and early morning. In warm weather, people are apt to be relaxing out-of-doors in the evening and on week-ends. It is at these times that the citizen is most conscious and resentful of noise intrusion, and therefore at these times that you should be most reluctant to fly noisily near residential areas.

Notes

FIGURE 1
TREND OF HELICOPTER NOISE LEVELS

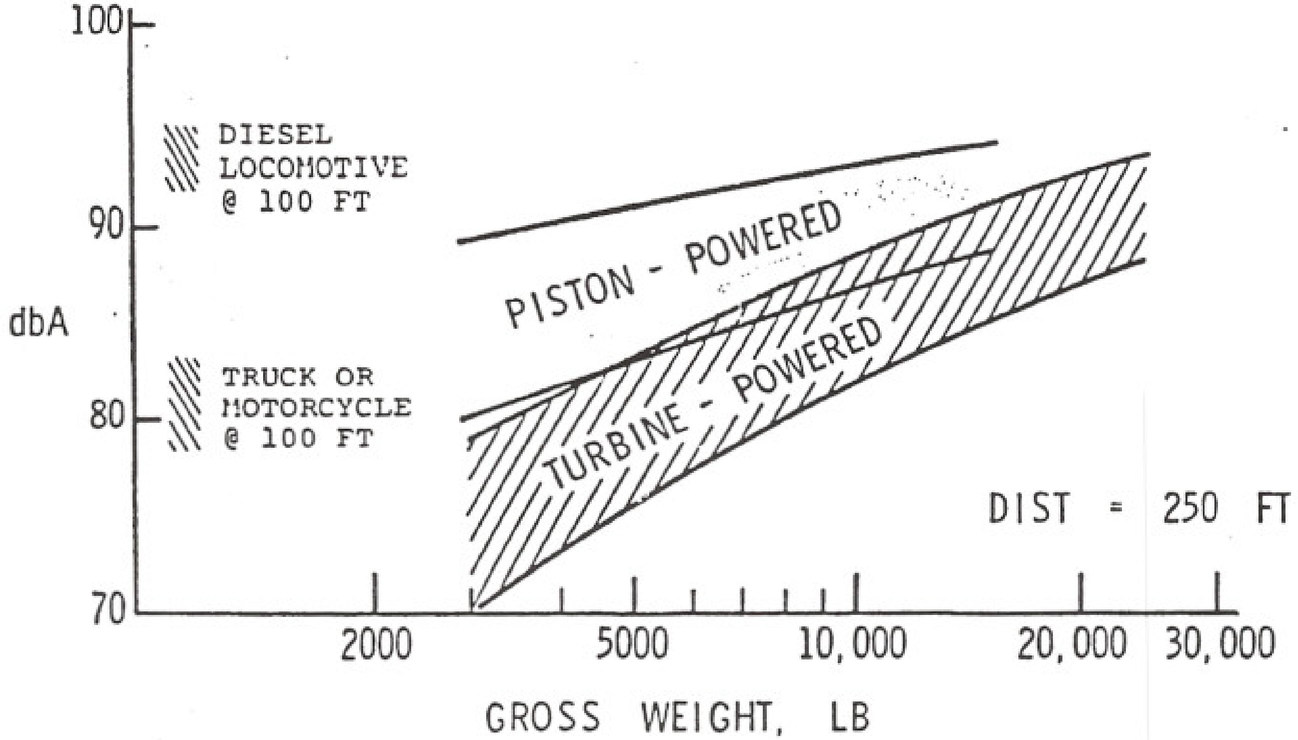

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FIGURE 2

NOISY FLIGHT OPERATIONS - MEDIUM HELICOPTERS

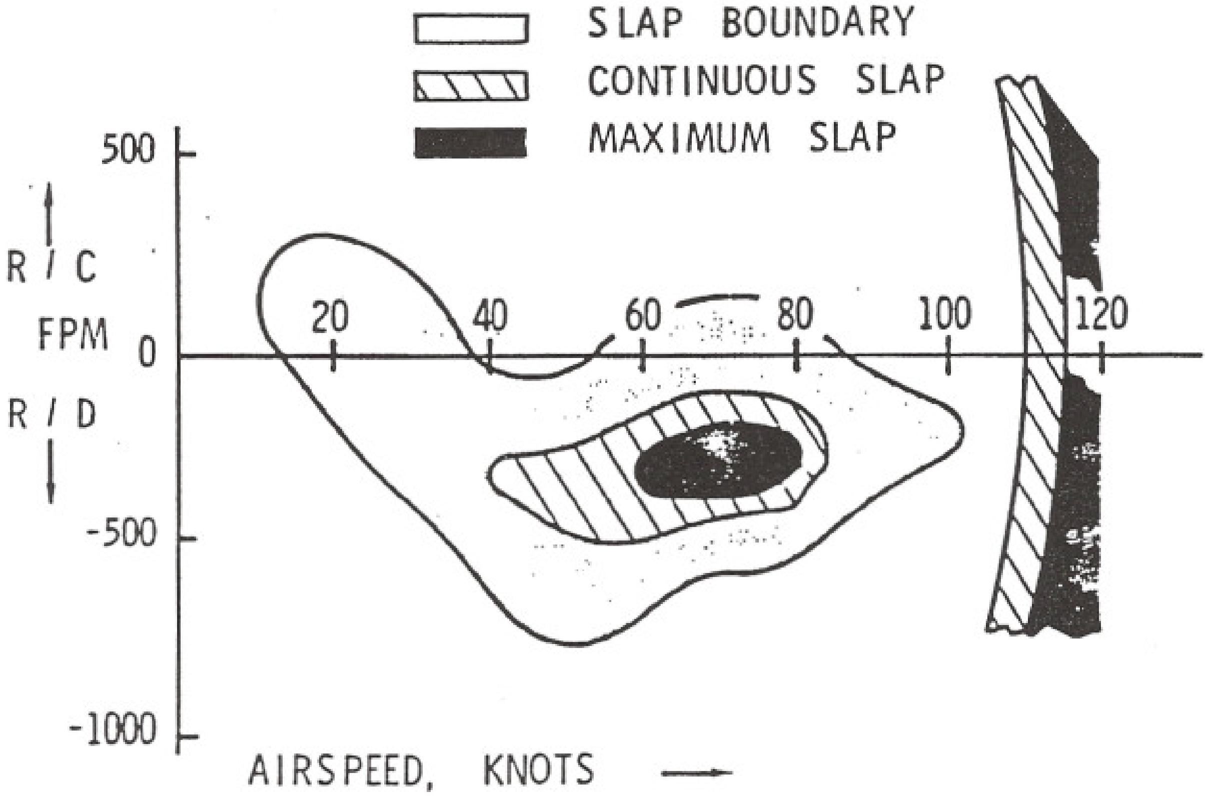

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FIGURE 3

NOISY MANEUVERS - MEDIUM HELICOPTERS

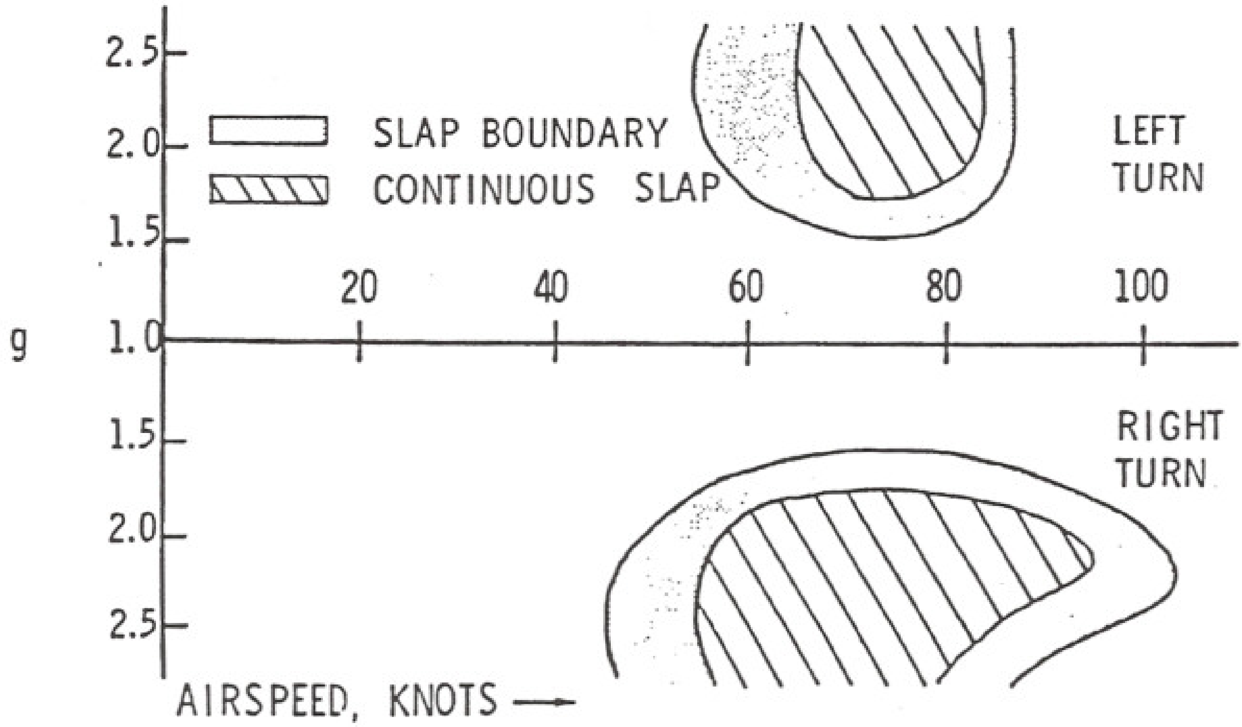

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FIGURE 5
GROUND NOISE - EXPOSURE FOOTPRINT

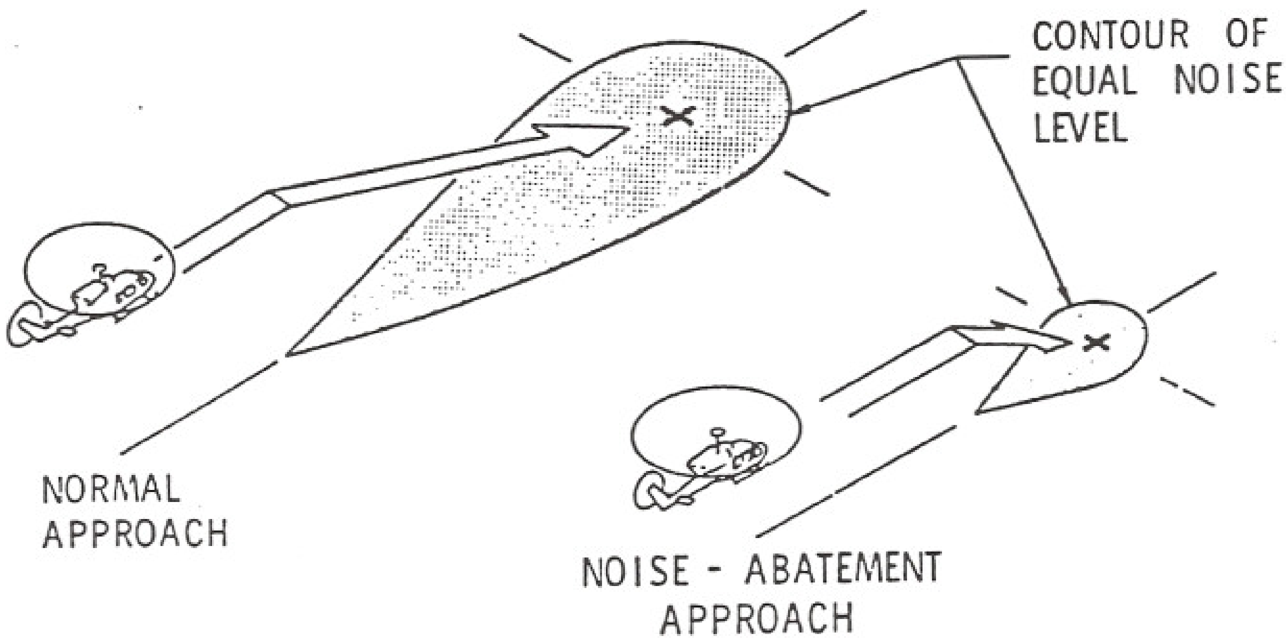

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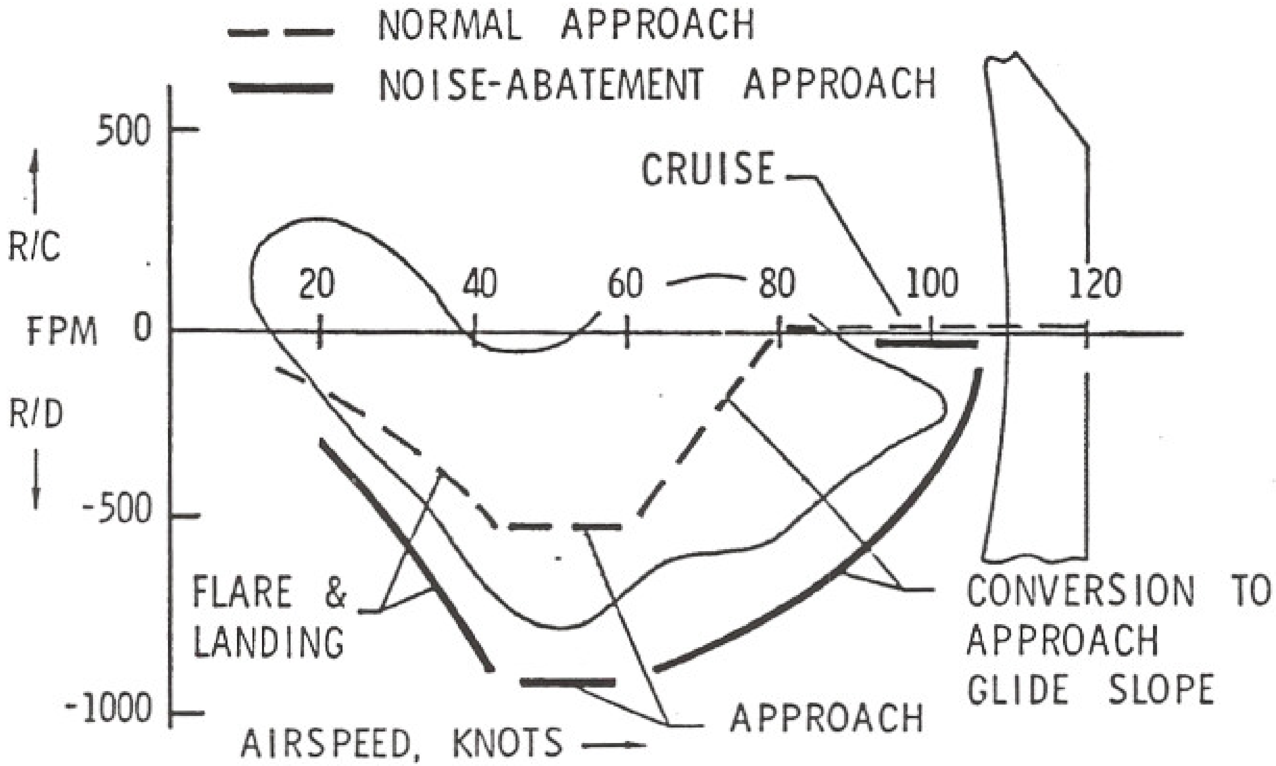
FIGURE 4

NOISE - ABATEMENT FLIGHT TECHNIQUE--MEDIUM HELICOPTER



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